An Assessment of Four Upper Fraser River Chinook Salmon Sport Fisheries, 1986

by N.D. Schubert

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ABSTRACT

Schubert, N.D. 1988. An assessment of four upper Fraser River chinook salmon sport fisheries, 1986. Can. MS Rep. Fish. Aquat. Sci. 1890: 52p.

The retention of chinook salmon (**Oncorhynchus tshawytscha**) adults in Fraser River system sport fisheries was eliminated in 1980 in response to escapement declines. By 1986, improved escapements permitted the reopening of sport fisheries for chinook adults in the Bowron, Clearwater, Quesnel and Shuswap rivers. Fishery regulations permitted retention of chinook adults on two weekdays per week with individual daily and annual catch quotas of one and ten, and fishery catch ceilings. Each fishery was evaluated using either a roving or a hybrid on-site survey.

A total of 1,515 anglers were interviewed in the four study areas. An estimated 15,242 angler hours were expended to harvest an estimated 359 chinook adults, 56 chinook jacks, 3 coho adults, 155 rainbow trout, 69 Dolly Varden char, 41 whitefish and 16 squawfish. Estimated releases totalled 10 chinook adults, 4 chinook jacks, 243 rainbow trout, 1 steelhead trout, 16 Dolly Varden char, 28 whitefish and 7 suckers. Four of the harvested chinook adults and 13 of the harvested chinook jacks were marked with adipose fin clips.

Key words: upper Fraser River, sport fisheries, chinook salmon, angler effort, harvest, release.

RÉSUMÉ

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En 1980, il a été interdit aux pêcheurs sportifs de garder les saumons quinnats (**Oncorhynchus tshawytscha**) adultes capturés dans le système du fleuve Fraser par suite du déclin de l'echappée. En 1986, on a pu réouvrir les pêches sportives dans les rivières Bowron, Clearwater, Quesnel et Shuswap étant donné l'amélioration de l'échappée. En vertu de la réglementation, les périodes d'ouverture ont été limitées à deux jours ouvrables par semaine, la limite des prises quotidiennes et annuelles a été fixée à un et dix saumons respectivement et des plafonds des prises ont été établis. Chaque pêcherie a été évaluée en fonction d'une levée itinérante ou d'une levée hybride sur place.

Dans quatre zones expérimentales, on a interviewé un total de 1 515 pêcheurs sportifs. La pêche sportive de 359 quinnats adultes, 56 quinnats mâles précoces, 3 cohos adultes, 155 truites arc-en-ciel, 69 Dolly Varden, 41 corégones et 16 sauvagesses du nord a requis 15 242 heures estimatives de pêche. Les remises à l'eau totales comprenaient 10 quinnats adultes, 4 quinnats mâles précoces, 243 truites arc-en-ciel, 1 truite arc-en-ciel anadrome, 16 Dolly Varden, 28 corégones et 7 meuniers. Quatre des quinnats adultes et 13 des quinnats mâles précoces capturés ont été marqués par rognage de la nageoire adipeuse.

Mots-clés: partie supérieure du fleuve Fraser, pêches sportives, saumon quinnat, effort de pêche sportive, exploitation, remise à l'eau.

INTRODUCTION

The harvest of chinook salmon (**Oncorhynchus tshawytscha**) adults in Fraser River sport fisheries was eliminated in June 1980 as one of several measures intended to improve chinook escapements. Because escapements of Fraser River chinook salmon subsequently improved (Farwell **et al.** 1987), sport fisheries were reestablished in the Bowron, Clearwater, Quesnel and Shuswap rivers in 1986 (Fig. 1), complementing fisheries reestablished in the Vedder-Chilliwack and lower Fraser rivers in 1984 and 1985, respectively. These systems were selected because escapements were improving at a rate faster than expected, the stocks were being enhanced, and harvest could be restricted to single stocks.

Because sport fisheries for chinook adults had not been permitted for at least six years, data needed to predict effort and harvest levels were unavailable. Detailed assessment studies were conducted in each area, therefore, to monitor inseason fishery performance, to evaluate stock impacts and to provide data upon which future management decisions could be based.

This report describes the study design and field procedures and documents the results of the 1986 sport fishery studies in the Bowron, Clearwater, Quesnel and Shuswap rivers. The report presents estimates of angler effort, harvest and release by species and mark type, and angler characteristics. The report concludes with a discussion of results and recommendations for changes in the management of future fisheries.

STUDY AREA DESCRIPTION

BOWRON RIVER

The Bowron River arises in the Cariboo Mountains of central British Columbia and flows in a northwesterly direction for approximately 230 km, entering the Fraser River 50 km east of Prince George (Fig. 2). In 1986, chinook sport fishing was permitted in a 60 km section between the Bowron Forest Road and Highway 16 bridges. Access to this area was limited primarily to road crossings, although the open section was also accessible by boat. The Highway 16, Bowron Forest Road and Beaver Forest Road bridges and two disused logging roads within three kilometers of the Beaver Forest Road Bridge provided the main access points. Bowron River chinook, which migrate through the open area in August and September, were the only chinook available to the sport fishery. Berry and Kahl (MS 1982) and Gosselin **et al.** (MS 1987) provided a more detailed description of the river system.

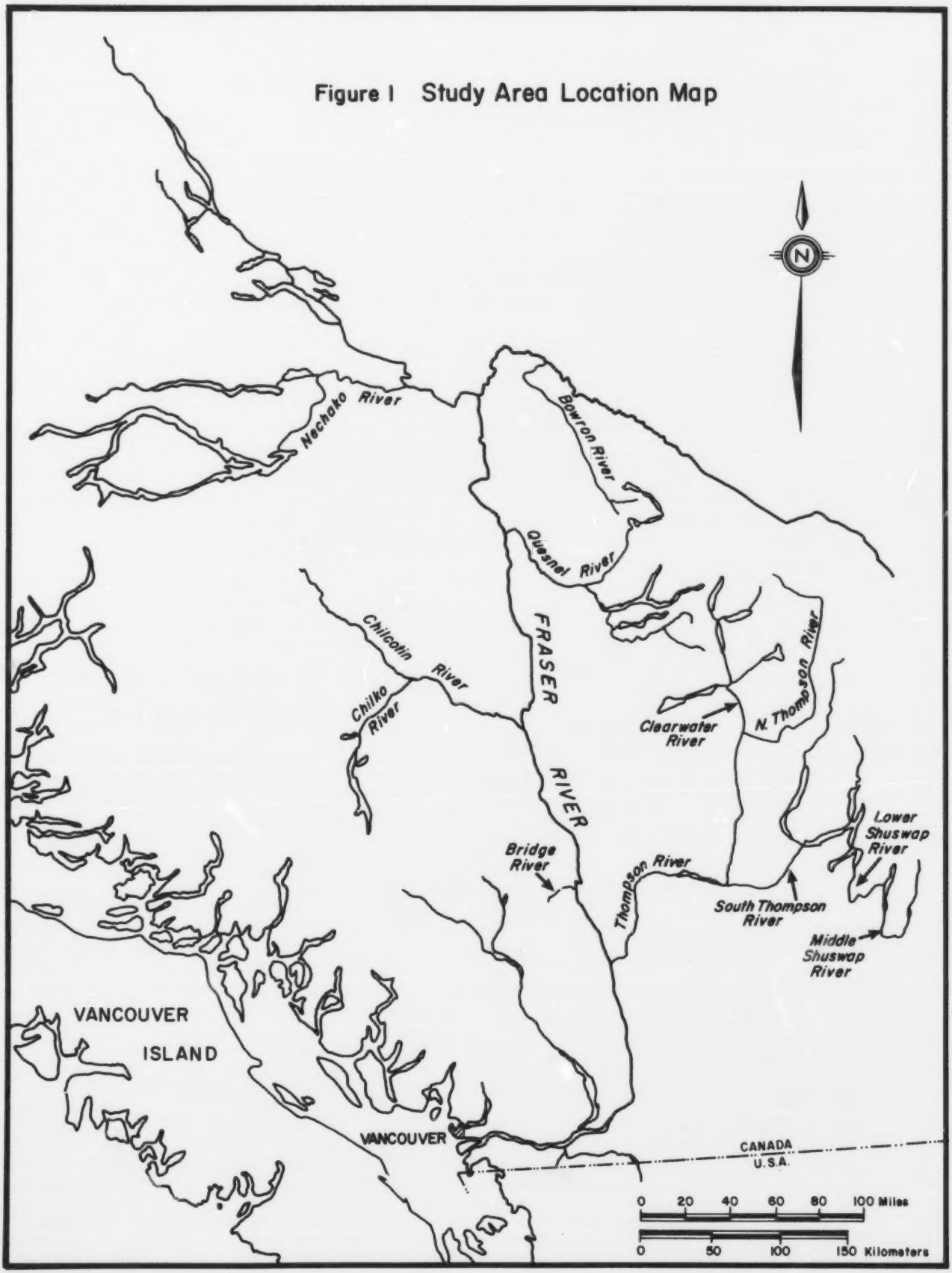
CLEARWATER RIVER

The Clearwater River arises in the Cariboo Mountains and flows in a southerly direction for 160 km, entering the North Thompson River near Clearwater (Fig. 3). In 1986, chinook sport fishing was permitted in a 56 km section between the river mouth and Clearwater Lake. The river was accessible from two roads, one to the west between the mouth and Mahood River, the other to the east between Mahood River and Clearwater Lake. The river was not easily accessible by boat. Clearwater River chinook, which migrate through the open area in August and September, were the only chinook available to the sport fishery. Berry and Kahl (MS 1982) and Paish **et al.** (MS 1973) provided a more detailed description of the river system.

QUESNEL RIVER

The Quesnel River originates in the Cariboo Mountains and flows in a northwesterly direction, entering the Fraser River at Quesnel (Fig. 4). In 1986, chinook sport fishing was per-

Figure 1 Study Area Location Map



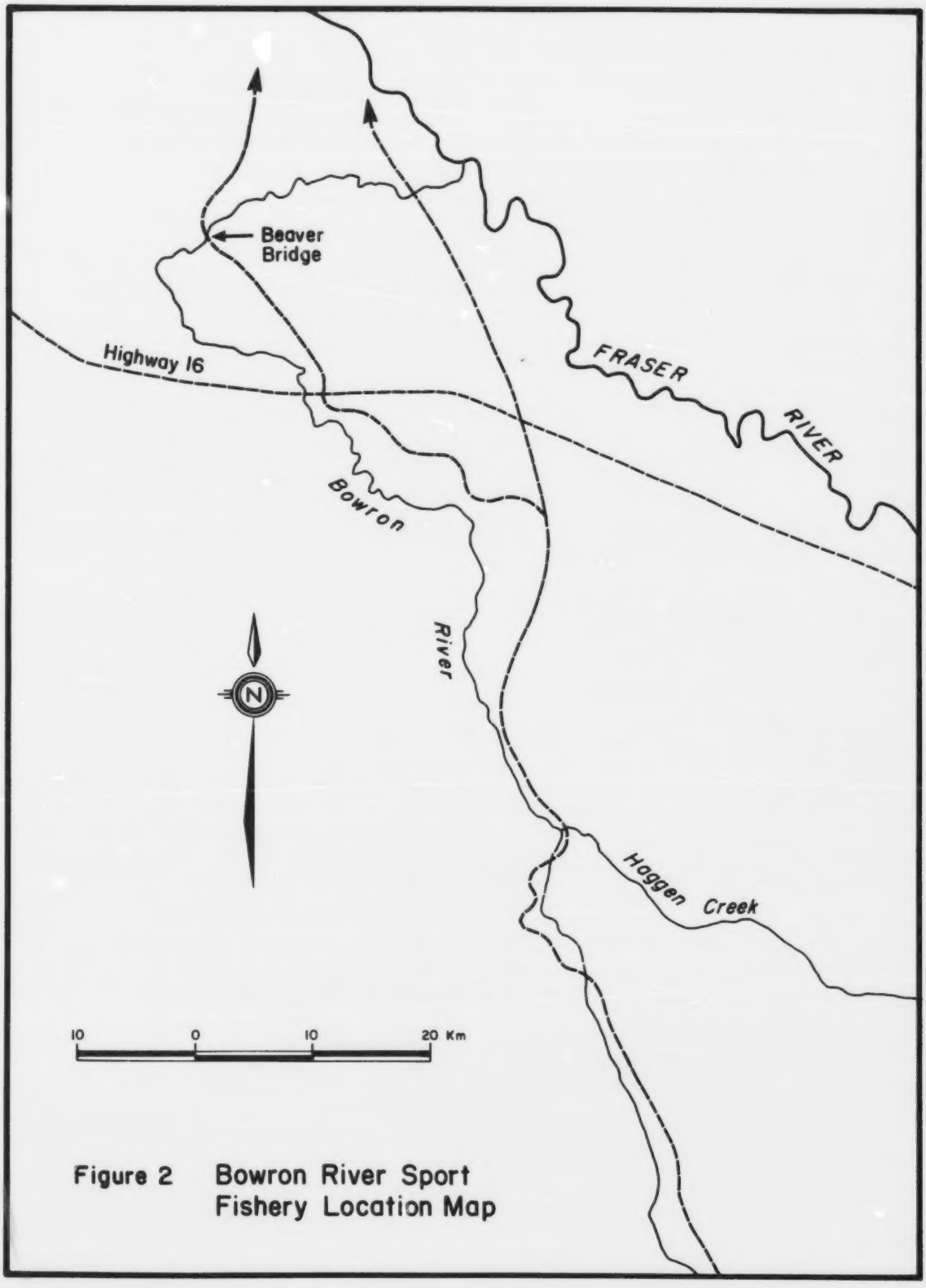


Figure 2 Bowron River Sport Fishery Location Map

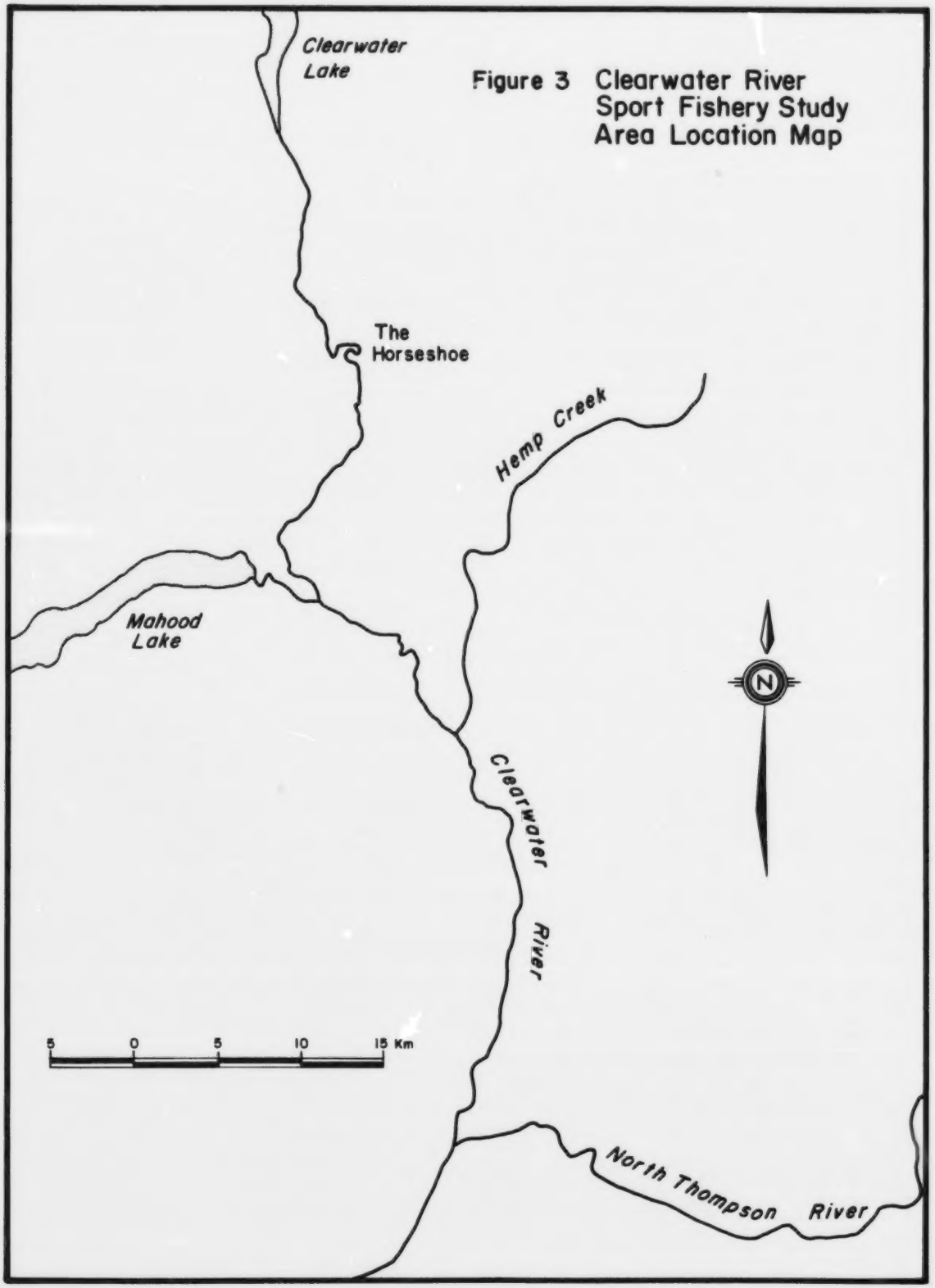
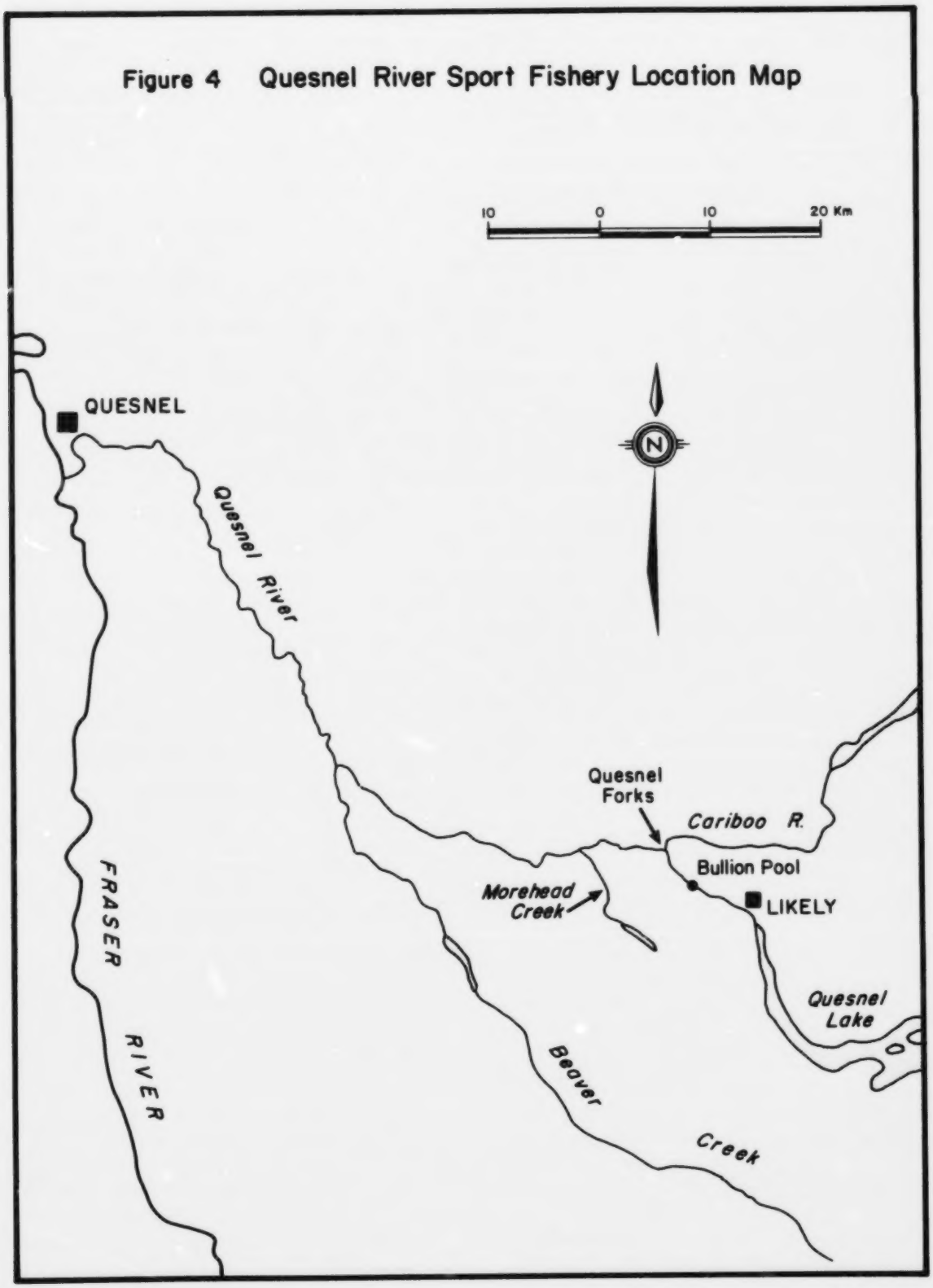


Figure 3 Clearwater River Sport Fishery Study Area Location Map

Figure 4 Quesnel River Sport Fishery Location Map



mitted in an 11 km section between the Cariboo River confluence and Quesnel Lake. The river was accessible by road between Quesnel Lake and Bullion Pool, and at Quesnel Forks. Chinook salmon are distributed through the system up to Quesnel Lake and in the Horsefly River, a Quesnel Lake tributary; however, only Quesnel River chinook, which migrate through the open area in August and September, were available to the sport fishery. Berry and Kahl (MS 1982) and Helm **et al.** (MS 1980) provided a more detailed description of the river system.

SHUSWAP RIVER

The Shuswap River originates in the Monashee Mountains and flows in a northwesterly direction, entering Mara Lake east of Salmon Arm. In 1986, chinook sport fishing was permitted in two areas, the middle Shuswap River (19 km) between Mabel Lake and the Shuswap Falls dam, and throughout the lower Shuswap River (68 km)(Fig. 5). The river was accessible throughout the open areas from a number of roads and by boat. Two distinct chinook stocks spawn in the system. Middle Shuswap River chinook were available in both fishing areas during July and August. Lower Shuswap River chinook were available to the lower Shuswap River fishery in September. Berry and Kahl (MS 1982) and Fedorenko and Pearce (1982) provided a more detailed description of the river system.

FISHERY REGULATIONS

Since previous sport fishery assessment data were unavailable, the 1986 fisheries were closely regulated to ensure catch remained below levels which might impact the chinook stock rebuilding program (Anon. MS 1986). Each fishery was open only two days per week (Tuesday and Friday), daily and annual angler catch limits of one and ten, respectively, were imposed, and each fishery was managed to a specific catch ceiling. Regulations are detailed by fishery in Table 1.

STUDY DESIGN

GENERAL CONSIDERATIONS

The development of study designs for the four sport fisheries was constrained by both the lack of previous

Table 1. Summary of 1986 sport fishery regulations in the four upper Fraser River study areas.

Area	Open period	Angler quotas		Days open per week	Total days open	Catch ceiling
		Daily	Annual			
Bowron River	Jul 15 to Aug 15	1	10	2	10	300
Clearwater River	Jul 15 to Aug 15	1	10	2	10	300
Quesnel River	Aug 1 to Aug 29	1	10	2	9	200
Lower Shuswap River	Jul 29 to Aug 8	1	10	2	4	50
	Sep 9 to Sep 23	1	10	2	5	450
Middle Shuswap River	Jul 29 to Aug 8	1	10	2	4	[a]

[a] Included in ceiling for lower Shuswap River (July 29 to August 8).

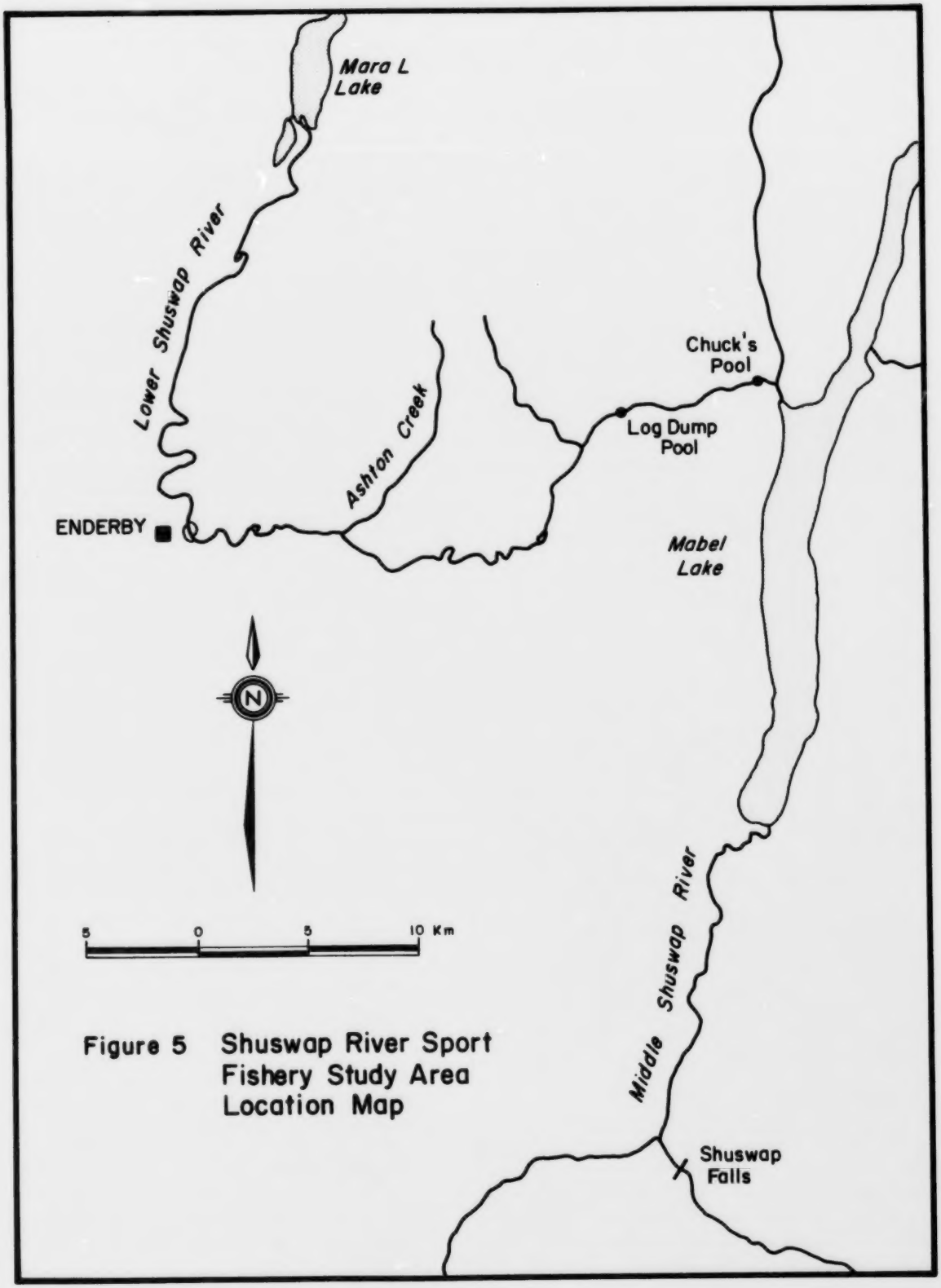


Figure 5 Shuswap River Sport Fishery Study Area Location Map

assessment information and the short duration of the fisheries. Because the fisheries had been closed to the retention of chinook adults for at least six years, fishery characteristics such as the magnitude, distribution and hourly pattern of angler effort were unknown. As well, the fisheries ranged in duration from four to ten days, making the precise estimation of angler effort difficult.

The study design for each area was based on a prefishery estimate of expected angler effort, the extent of the open area and manpower availability. The fisheries were assessed using either a roving or a hybrid study design. The roving design was similar to that described by Malvestuto **et al.** (1978), except angler effort was estimated from a daily profile developed from interview data in the manner described by Hickey **et al.** (1987). The hybrid design, which combined access point and "instantaneous" rod count surveys, was similar to that described by the DPA Group (MS 1985a), except a roving survey provided catch per unit effort (CPUE) information as well as the instantaneous count. In cases where assumptions regarding angler effort concentrations were uncertain, the overall design was modified so that either analytic technique could be used.

The fisheries were assessed each open day and, because the fisheries were restricted to weekdays, only a single time stratum was generally needed. Catch was estimated for all species; however, estimates included only those days open to chinook angling.

BOWRON RIVER

The Bowron River sport fishery was assessed, using a hybrid design, between July 15 and August 15, 1986. Two surveyors worked one of two randomly selected eight hour shifts (7:00 AM to 3:00 PM; 1:00 PM to 9:00 PM) which encompassed all daylight hours. One surveyor was stationed at Beaver Bridge, the area of maximum expected angler effort. A second surveyor assessed the remaining sites.

Upon arrival at Beaver Bridge, the surveyor requested that anglers report for an interview at the end of their fishing trip. On the morning shift, the surveyor also inquired if any anglers had left prior to 7:00 AM. The surveyor then remained at the site access to conduct hourly angler counts and exit interviews. At the end of the evening shift, any anglers still fishing were interviewed. The surveyor recorded angler trip length (to time of interview and expected additional time, if any), target species, number and species harvested or released, identifying marks on harvested fish (fin or maxillary clip), gear type and if the angler was in B.C. to visit Expo 86. When possible, the harvest was inspected to confirm species and mark identification. An interview form was completed for each angler; however, if the angler was unresponsive or if response reliability was questionable, the form was voided.

The second surveyor travelled a predetermined route by automobile, with a randomly selected start point and direction of travel. The surveyor's rate of travel through the fishery was standardized to ensure that a complete circuit encompassed seven hours. Anglers were approached on foot and interviewed as above. In addition to the interviews, the surveyor conducted a one hour instantaneous rod count of the entire study area at a randomly selected time each survey day. No interviews were conducted during the rod count.

CLEARWATER RIVER

The Clearwater River sport fishery was assessed, using a roving design, between July 15 and August 15,

1986. A single surveyor, working one of two randomly selected eight hour shifts, assessed the fishery between the mouth and Mahood River (see Bowron River roving survey shifts and procedures). The fishery between Mahood River and Clearwater Lake was also assessed daily; however, an absence of angler effort made full shifts unnecessary. Data were recorded by region of angler encounter but were pooled for analysis because the number of interviews in any region was small.

QUESNEL RIVER

The Quesnel River sport fishery was assessed, using a roving design complemented by a complete census at two sites, between August 1 and August 29, 1986. One surveyor, stationed at Quesnel Forks from August 1 to 19 and at Bullion Pool from August 22 to 29, worked a single shift encompassing all daylight hours (7:00 AM to 9:00 PM). The second surveyor, working one of two randomly selected nine hour shifts (7:00 AM to 4:00 PM; 12:00 AM to 9:00 PM), surveyed the remaining sites.

The daily procedures used during the access point (Quesnel Forks and Bullion Pool) and roving surveys were identical to those described above (see Bowron River), except the roving survey included two randomly selected instantaneous rod counts.

A concern in designing the Quesnel survey was that angler effort would be insufficient to permit the estimation of total effort from interview data. The complete census and the increased frequency of instantaneous rod counts were intended to provide alternate methods to estimate effort.

SHUSWAP RIVER

The Shuswap River sport fishery was assessed using two techniques. A roving design was used between July 29 and August 8, 1986, and a hybrid design was used between September 9 and 23, 1986. Three surveyors worked one of two randomly selected eight hour shifts: 6:00 AM to 2:00 PM and 1:00 PM to 9:00 PM during the early fishery, and 5:00 AM to 1:00 PM and 1:00 PM to 9:00 PM during the late fishery. Shift time was adjusted for the late fishery on the basis of early fishery assessment data.

The early fishery was assessed using a roving design. The open area was partitioned into three routes, and each surveyor followed the daily procedures described for the Bowron River. The identification of effort distribution patterns during the early fishery permitted the use of a hybrid design to assess the late fishery. One surveyor was stationed at each of Chuck's and Log Dump pools, while the third surveyor assessed the remaining areas. Daily procedures were identical to those described for the Bowron River, except instantaneous rod counts occurred during the period of expected peak effort (6:00 AM to 7:00 AM on the morning shift and 7:00 PM to 8:00 PM on the afternoon shift).

DATA MANAGEMENT

Data storage and analysis were conducted on an IBM-AT compatible microcomputer. A custom designed data entry program (DPA Group Inc. MS 1985b) was used to generate ASCII files. The hybrid survey files were then imported into a custom designed analysis program (DPA Group Inc. MS 1986), while the roving survey files were imported into a spreadsheet program for analysis.

The data were verified in three steps. First, all field data sheets were examined to ensure compliance with study procedures. Second, the data entry program performed 31 automatic error checks, including duplication detection, code validity, and range and consistency verification.

Third, the ASCII data files were imported to a spreadsheet program for final verification with the field data sheets.

DATA ANALYSES

BOWRON RIVER

Angler Effort

Profiles of daily angler effort were generated from hourly rod counts at Beaver Bridge, with effort before 7:00 AM and after 9:00 PM reconstructed from interview data. Hourly effort was weighted to compensate for the sampling imbalance which resulted from overlapping survey shifts.

Mean sample-day angler effort (hours) was calculated by dividing the mean rod count (from both the access point and roving surveys) in a given time block (hour) by the proportion of daily effort occurring in that time block. The roving survey was designed with random instantaneous rod counts to provide an alternate effort estimation technique if Beaver Bridge did not prove to be a major fishing area. As a result, mean sample-day angler effort was estimated from the two counts (July 25 and August 8) which occurred in the same time block and the effort profile recorded at Beaver Bridge. Total angler effort was the product of the mean daily angler effort and the number of days in the stratum. The mathematical relationships, based on DPA Group Inc. (MS 1985a), are reported below. Variance calculations are detailed in Appendix 16.

1) Estimated daily total rods fishing during each hourly time block ($\hat{R}_j$):

$$\hat{R}_j = \sum_i N/n_{ij} \sum_k r_{ijk}$$

2) Estimated proportion of daily angler effort occurring during the instantaneous rod count time block ($\bar{p}_{j^*}$):

$$\bar{p}_{j^*} = \frac{\hat{R}_{j^*}}{\sum_j \hat{R}_j}$$

3) Estimated mean rod count during the instantaneous rod count time block ($\bar{y}_{j^*}$):

$$\bar{y}_{j^*} = \sum_k \frac{y_{j^*k}}{n_{j^*}}$$

4) Estimated study period angler effort (E) in hours:

$$E = N \frac{\bar{y}_{j^*}}{\bar{p}_{j^*}}$$

where N = total days in study period,
n_{ij} = number of interview sample days at site i (in this case, Beaver Bridge only),
r_{ijk} = rod count at site i (Beaver Bridge) at hour j on day k,
$\hat{R}_{j^*}$ = estimated total effort (hours) during the instantaneous rod count time block (j*),
y_{j^*k} = instantaneous rod count at all sites (access point and roving surveys) on day k,
n_{j^*} = number of instantaneous rod counts at hour j*.

Catch Per Unit Effort

CPUE was calculated by species and mark group using a total ratio estimator (Von Geldern, Jr. and Thomlinson 1973; Malvestuto 1983), i.e. for the surveyed sites (Beaver Bridge and roving), the total estimated catch was divided by the total estimated effort (to time of interview). Estimates were derived from interview data which were weighted by the proportion of study period stints which were sur-

veyed (for the purpose of analyses, the day was divided into three stints: 7:00 AM to 1:00 PM; 1:00 PM to 3:00 PM; and 3:00 PM to 9:00 PM) and, for access point sites, by the proportion of anglers in each hour who left the site without an interview. The former was necessary to account for sampling imbalances resulting from overlapping survey shifts. CPUE was calculated separately for harvested (HPUE) and released (RPUE) fish; however, RPUE was not calculated for marked fish because angler mark recognition was considered unreliable. The mathematical relationships, based on DPA Group Inc. (MS 1985a), are reported below.

5) Estimated total study period catch to time of interview at the surveyed sites ($\hat{X}$):

$$\hat{X} = \sum_i \sum_l \frac{1}{a_{il}} \sum_f \sum_g \sum_u \frac{x_{ilfqu}}{a_{ilfq}}$$

6) Estimated total study period angler hours to time of interview at the surveyed sites ($\hat{T}$):

$$\hat{T} = \sum_i \sum_l \frac{1}{a_{il}} \sum_f \sum_g \sum_u \frac{t_{ilfqu}}{a_{ilfq}}$$

7) Estimated catch per angler hour at the sites surveyed ($\bar{c}$):

$$\bar{c} = \frac{\hat{X}}{\hat{T}}$$

where a_{il} = proportion of total study period stints of type l for site i which were surveyed,

a_{ilfq} = proportion of anglers leaving in time block q on stint f of stint type l at site i who were interviewed,

x_{ilfqu} = catch to time of interview by angler u leaving in time block q on stint f of stint type l at site i,

t_{ilfqu} = hours fished to time of interview by angler u leaving in time block q on stint f of stint type l at site i.

Harvest and Release

Total harvest and release, estimated by species and mark group, was the product of study period effort and the corresponding value of HPUE or RPUE.

8) Total study period catch (C):

$$C = \bar{c}\, E$$

Harvest Rate

In all study areas, the terminal harvest rate of chinook adults was calculated by dividing the estimated harvest by the sum of the estimated harvest and the observed escapement (provided by field staff). Harvest rates were not calculated for other species because escapement was unknown.

Angler Characteristics

In all study areas, the following unweighted angler attributes were summarized by site and day: mean angler day length by weather type (clear, overcast and rain), mean angler day length from complete and incomplete trip interviews, numbers of anglers targeting on each species, preferred gear type, and the incidence of anglers in B.C. to visit Expo 86.

To estimate mean angler day length, the roving survey data were first corrected for length of stay bias, described by Lucas (1963), as follows:

$$\bar{d} = \frac{\sum_d n_d}{\sum_d n_d/d}$$

where $\bar{d}$ = mean angler day length (hours),
d = angler day length (in one hour increments),
n_d = number of incomplete trip interviews of day length d.

Estimates of angler day length from complete and incomplete surveys, weighted by number of interviews, were combined to estimate mean angler day length for the roving survey areas. For hybrid surveys, study period angler day length was estimated by combing access point and roving survey estimates weighted by angler effort.

CLEARWATER RIVER

For the purpose of analysis, the Clearwater River study was stratified into two time periods: July 15 to August 5 and August 8 to 15, 1986.

Angler Effort

Profiles of hourly angler effort were generated from angler interview data, with hourly effort weighted to compensate for sampling imbalances resulting from overlapping survey shifts and random effort counts.

Total sample day angler effort (hours) was calculated by dividing the rod count by the proportion of the daily effort occurring in that time block. Early morning and late afternoon rod counts were excluded since the tails of the effort profiles were extremely sensitive to minor deviations from mean conditions and could potentially produce substantial error. Mean daily angler effort (and its variance) was calculated for each stratum. Strata totals were the product of the mean daily angler effort and the number of days in each stratum. Total angler effort and associated variance was produced by combining strata totals and variances. The mathematical relationships, based on Mendenhall **et al.** (1971), were:

9) Estimated stratum mean daily effort ($\bar{e}_h$) in hours:

$$\bar{e}_h = \sum_k \left[y_j{}^*{}_k / \bar{p}_j{}^* \Big/ n_j{}^* \right]$$

10) Total study period angler effort (E) and variance (Var(E)), all in hours:

$$E = \sum_h \bar{e}_h N_h$$

$$Var(E) = \sum_h \left[N_h^2 \left(s_h^2 / n_h \right) \left(fpc_h \right) \right]$$

where $y_j{}^*{}_k$ = instantaneous rod count at all sites on day k,
$\bar{p}_j{}^*$ = proportion of daily angler effort (hours) during the instantaneous rod count time block (as determined from interview data),
$n_j{}^*$ = number of instantaneous rod counts at hour j*,
N_h = number of days in stratum h,
s_h = sample variance in stratum h,
fpc_h = finite population correction for stratum h.

Catch Per Unit Effort

CPUE was calculated by species and mark group for each stratum using a total ratio estimator. In general, CPUE was estimated as described above (see Bowron River), except observed catch and effort to time of interview were used, and the data were not weighted by the proportion of anglers leaving without being interviewed. CPUE's and their variances were calculated as follows:

11) Catch per unit effort ($\bar{c}$):

$$\bar{c} = \sum_{1} \left[\frac{w_1 (\sum_{u} x_u / \sum_{u} t_u)}{\sum_{1} w_1} \right]$$

12) Variance of CPUE ($Var(\bar{c})$)

$$Var(\bar{c}) = (1/\bar{t}^2) \sqrt{\frac{((x_u - \bar{c})t_u)^2}{n(n-1)}}$$

where x_u = catch to time of interview of angler u,
t_u = hours fished to time of interview by angler u,
$\bar{t}$ = mean time spent angling to time of interview,
n = number of anglers interviewed in stratum,
w_1 = proportion of stints at type 1 which were surveyed.

Harvest and Release

Total harvest and release, by species and mark group, was calculated as in Equation 8. Variance was calculated as follows:

13) $Var(C) = E\ Var(\bar{c}) + \bar{c}\ Var(E) + Var(E)Var(\bar{c})$

QUESNEL RIVER

Quesnel River data were analysed in two ways. First, because the access point surveys encompassed all daylight hours, data were treated as a complete census. Second, data from the remaining sites were treated in a manner similar to that discussed for the Clearwater River. Profiles of angler effort generated at the access points were not used because effort profiles at those sites were considered atypical of the rest of the fishery.

SHUSWAP RIVER

Early Fishery

The early fishery roving survey data were analysed using the techniques described for the Clearwater River study. For the purpose of analysis, the study area was stratified into lower and middle Shuswap river fisheries and separate estimates of angler effort, CPUE and catch were generated for each.

Late Fishery

The late fishery hybrid survey data were anaylsed using the procedure described for the Bowron River study. For the purpose of analysis, angler effort was calculated from profiles observed at Chuck's and Log Dump pools and from instantaneous counts from both the roving and access point surveys; CPUE was generated from information collected at Chuck's Pool, Log Dump Pool and the roving survey.

RESULTS

Study results for the four upper Fraser River chinook sport fisheries are summarized in Tables 2, 3 and 4. Based on 1,515 angler interviews from assessment studies encompassing all open days, an estimated 15,242 angler hours were expended to harvest (release) 359 (10) chinook adults, 56 (4) chinook jacks, 3 coho adults (**Oncorhynchus kisutch**), 155 (243) rainbow trout (**Salmo gairdneri**), 69 (16) Dolly Varden char (**Salvelinus malma**), 41 (28) whitefish (**Prosopium sp.**), 16 squawfish (**Ptychocheilus oregonensis**) and 0 (7) suckers (**Catostomus sp.**). Chinook harvest rates ranged from 0.05% to 8.42%.

In general, the fisheries were successful in attracting anglers primarily interested in catching chinook salmon; only Clearwater River anglers were more interested in catching other species. The average angler fished

Table 2. Summary of 1986 catch and angler effort by fishery (95% confidence limits in parentheses).

	Bowron River	Clearwater River	Quesnel River	Shuswap River		All areas
				Early	Late	
Number of interviews	411 -	84 -	319 -	214 -	487 -	1,515
Angler effort (hr)	3,179 (418)	626 (266)	1,484 (448)	3,808 (1226)	6,145 (1248)	15,242
Angler effort (day)	721 -	155 -	488 -	1,082 -	1,252 -	3,698
Harvest						
Chinook adults	13 (12)	3 (8)	14[a] (14)	92 (65)	237 (54)	359
Chinook jacks	0 -	0 -	3 (7)	0 -	53[b] (26)	56
Coho adults	0 -	0 -	0 -	0 -	3 (2)	3
Rainbow	30 (26)	72 (40)	25 (17)	16 (37)	12 (6)	155
Dolly Varden	26 (26)	13 (16)	19 (10)	7 (16)	4 (4)	69
Whitefish	2 (2)	13 (20)	19 (16)	7 (16)	0 -	41
Squawfish	0 -	0 -	0 -	16 (27)	0 -	16
Release						
Chinook adults	7 (8)	0 -	3 (7)	0 -	0 -	10
Chinook jacks	0 -	0 -	0 -	0 -	4 (4)	4
Rainbow	42 (36)	184 (118)	17 (23)	0 -	0 -	243
Steelhead	1 (1)	0 -	0 -	0 -	0 -	1
Dolly Varden	16 (16)	0 -	0 -	0 -	0 -	16
Whitefish	4 (4)	8 (51)	3 (7)	13 (30)	0 -	28
Suckers	0 -	0 -	0 -	7 (21)	0 -	7

[a] Includes 4 with adipose clips.
[b] Includes 13 with adipose clips.

for 3.0 to 4.9 hours per day using bait, lures or a combination of the two; few fished with flies. Very few anglers were in B.C. to visit Expo 86, indicating that the major tourist event did not bias study results. Results by study area are detailed below.

BOWRON RIVER

Effort Distribution

A total of 411 anglers were interviewed during the study, 293 at Beaver Bridge and 118 in the remaining areas (Appendix 1). Instantaneous rod counts were conducted daily; however, only two occurred during time blocks appropriate to the analysis (Appendix 2). Angling occurred almost entirely at road access points although, toward the end of the fishery, some anglers were reported accessing the fishery over extended distances on foot (B. Huber, pers. comm.). These anglers were not included in the instantaneous rod count. Fifty-one percent of the total effort occurred at Beaver Bridge, with most of the remaining effort concentrated at Highway 16 and at a small access road downstream from Beaver Bridge. Very little effort occurred in the lower river at the Bowron Forest Road Bridge.

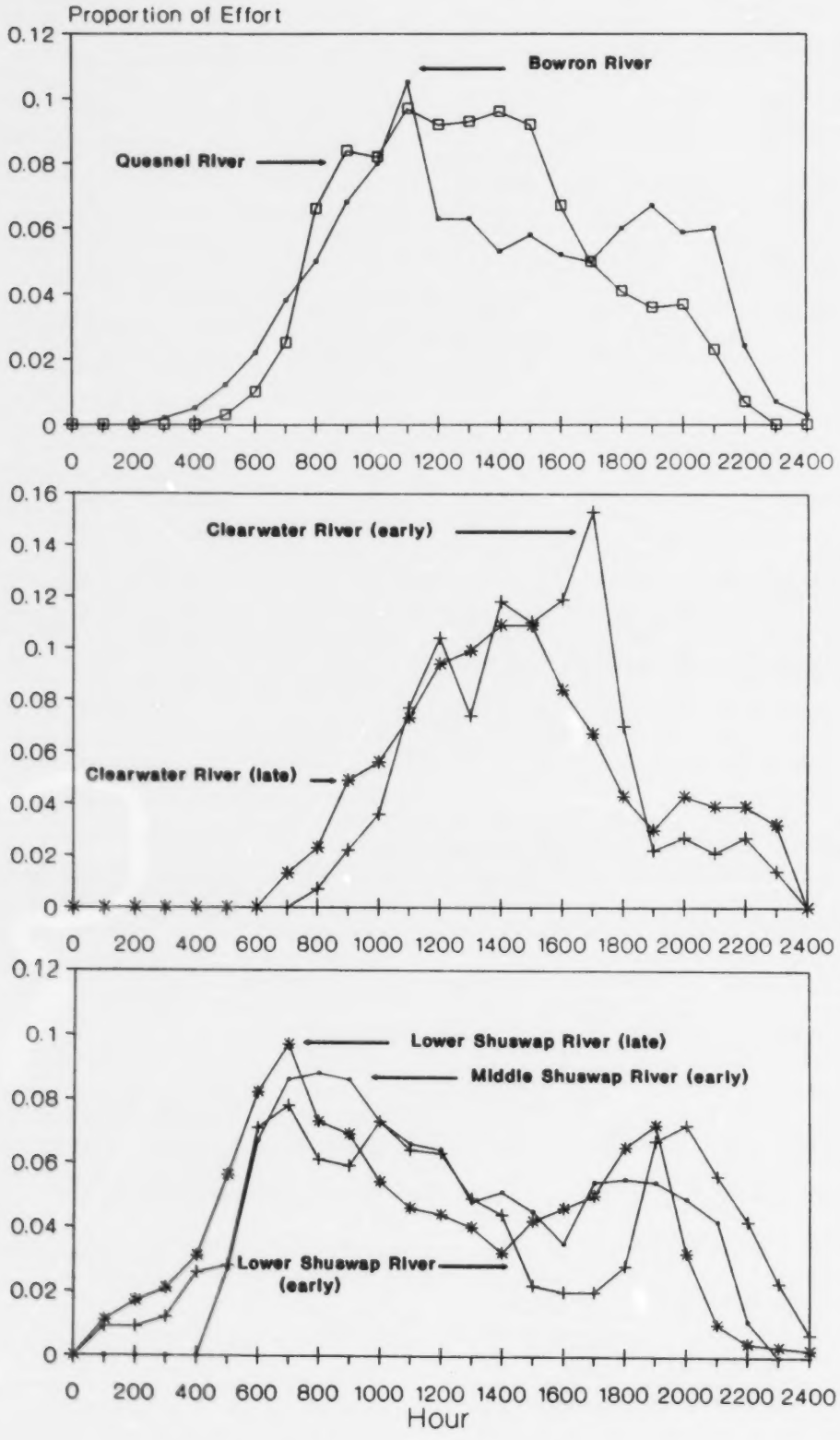


Fig. 6. Hourly angler effort profiles in the upper Fraser River sport fisheries, 1986.

Table 3. Summary of 1986 angler characteristics by fishery.[a]

	Bowron River	Clearwater River	Quesnel River	Shuswap River	
				Early	Late
Mean angler day length (hr)	4.41	4.05	3.04	3.52	4.91
Target species (%)					
Chinook	67.4	42.9	61.8	87.4	96.7
Trout [b]	5.8	51.2	13.5	0.9	0.2
Anything	26.8	6.0	24.8	11.7	3.1
Gear (%)					
Bait	9.7	27.4	22.9	29.0	32.7
Lure	54.7	40.5	39.8	57.9	33.9
Bait/Lure	34.8	26.2	32.9	12.2	33.1
Fly	0.7	6.0	4.4	0.9	0.4
Visiting B.C. to see Expo 86 (%)	1.7	6.0	1.3	0.0	0.0

[a] Data are unweighted, except angler day length adjusted for length of stay bias.
[b] Includes rainbow, whitefish or Dolly Varden.

Angler Effort

Daily Profile: Anglers fished from 0300 h to 2400 h, with 80% of the effort occurring between 0900 h and 2000 h (Appendix 3; Fig. 6). Angler effort peaked at 1100 h.

Total Angler Effort: Angler effort during the ten day Bowron River chinook fishery totalled 3,179 hours (Table 2). Of that total, an estimated 1,633 hours occurred at Beaver Bridge.

Catch Per Unit Effort

Harvest: Weighted HPUE, expressed as fish per hour, was estimated at 0.0041 for chinook adults (Appendix 4). HPUE at Beaver Bridge was lower than in other areas, averaging 0.0044 and 0.0064, respectively. The maximum daily HPUE of 0.059 was recorded during the roving survey on August 1. On the roving survey, chinook HPUE for complete and incomplete trip interviews averaged 0.0145 and 0, respectively.

Release: Weighted RPUE was estimated at 0.0022 for chinook adults (Appendix 4). Chinook adults were released at Beaver Bridge on July 29 and August 8.

Harvest

Harvest in the ten day Bowron River chinook sport fishery was estimated at 13 chinook adults, 30 rainbow trout, 26 Dolly Varden char and 2 whitefish (Table 2). Of the chinook harvest, 6 were taken at Beaver Bridge. None of the harvested chinook were missing an adipose fin.

Release

An estimated 7 chinook adults, 42 rainbow trout, 1 steelhead trout, 16 Dolly Varden char and 4 whitefish were intentionally released during the

Bowron River chinook sport fishery (Table 2).

Angler Characteristics

Angler day Length: Anglers fished an average 4.41 hours in 1986 (Table 3). Angler day length was considerably shorter for complete trip relative to incomplete trip interviews, averaging 4.61 and 5.60 hours, respectively (Appendix 1). Anglers fished an average 5.09, 4.48 and 6.57 hours on clear, overcast and rainy days, respectively.

Target Species: Anglers were interested in catching chinook (67%), Dolly Varden or rainbow (6%) or anything (27%) (Table 3).

Gear Type: Lures were the most commonly used gear (55%), followed by bait/lure combinations (35%), bait (10%) and flies (1%) (Table 3).

CLEARWATER RIVER

Effort Distribution

A total of 84 anglers were interviewed during the study, 35 from July 15 to August 5 and 49 from August 8 to 15 (Appendix 5). Instantaneous rod counts were obtained on five days, three in the early period and two in the late period (Appendix 6). Angling occurred from the mouth upstream to the Mahood River confluence; no anglers were observed above the Mahood River. An estimated two-thirds of the angler effort occurred in the lower river, downstream from Spahats Creek. Few anglers were observed near the mouth or near the Mahood River confluence.

Angler Effort

Daily Profile: Anglers fished from 0700 h to 2300 h, with over 75% of the daily angler effort occurring between 0900 h and 1800 h (Appendix 3; Fig. 6). Effort peaked at 1400 h during the initial seven open days and at 1700 h during the final three open days. During the latter period, fishing started earlier and effort tended to be higher near the end of the day.

Total Angler Effort: Angler effort during the ten day Clearwater River chinook fishery totalled 625.5 hours (Table 2). Thirty-five percent of the effort occurred in the first seven open days, with the remaining 65% in the final three days.

Catch Per Unit Effort

Harvest: HPUE for chinook adults was estimated at 0.0048 (Appendix 7). Because chinook adults were harvested only in the final three days of the fishery, HPUE during that period was considerably higher, estimated at 0.0083. The maximum daily HPUE of 0.016 was recorded on August 15, the only day chinook were harvested.

Release: Chinook were not released during the study period. RPUE's for other species are presented in Appendix 7.

Harvest

Harvest in the ten day Clearwater River chinook sport fishery was estimated at 3 chinook adults, 72 rainbow trout, 13 Dolly Varden char and 13 whitefish (Table 2). All of the Dolly Varden and 90% of the rainbow harvest occurred in the first seven days of the fishery, while all of the chinook harvest occurred in the final three days.

Release

An estimated 184 rainbow and 8 whitefish were released during the ten day opening, with most released in the initial seven days (Table 2). No chinook adults were released.

Angler Characteristics

Angler Day Length: Anglers fished an average 4.05 hours during 1986 (Table 3). Angler day length was considerably shorter for complete trip relative to incomplete trip interviews, averaging 2.50 and 5.54 hours, respectively (Appendix 5). Anglers fished an average 3.84, 4.12 and 5.21 hours on rainy, overcast and clear days, respectively; however, because most clear days occurred late in the study, it is uncertain if this difference reflected weather or the change in nature of the fishery during the final three days.

Target Species: Anglers were interested in catching chinook (43%), rainbow (including rainbow in conjunction with Dolly Varden or whitefish) (51%) or anything (6%) (Table 3). Rainbow were the primary target species (86%) in the initial seven days, shifting to chinook as the primary target species (71%) during the final three days of the fishery.

Gear Type: Lures were the most commonly used gear (41%), followed by bait (27%), bait/lure combinations (26%) and flies (6%) (Table 3). Gear preference was relatively constant through the study period.

QUESNEL RIVER

Effort Distribution

A total of 319 anglers were interviewed during the study, 89 at Quesnel Forks, 58 at Bullion Pool and 172 in the remaining areas (Appendix 8). At least two instantaneous rod counts were conducted each day (Appendix 9). Angling occurred at road access points throughout the open area. Approximately two-thirds of the effort occurred between Bullion Pool and the Likely Bridge, with a further 15% at Quesnel Forks and 17% near the Quesnel Lake outlet. Few anglers were observed between the Likely Bridge and the Narrows.

Angler Effort

Daily Profile: Anglers fished from 0300 h to 2200 h, with 75% of the effort occurring between 0700 h and 1600 h (Appendix 3: Fig. 6). Angler effort peaked near midday.

Total Angler Effort: Angler effort during the ten day Quesnel River chinook sport fishery totalled 1,484 hours (Table 2). Of that total, 260 and 184 hours were censused during access point surveys at Quesnel Forks and Bullion Pool, respectively.

Catch Per Unit Effort

Harvest: HPUE for chinook adults was estimated at 0.0116, 0.0000 and 0.0076 by the roving survey and by access point surveys at Quesnel Forks and Bullion Pool, respectively (Appendix 10). HPUE for chinook jacks was estimated at 0.0029 (roving survey only). The maximum daily chinook adult HPUE of 0.043 was recorded by the roving survey on August 29. On the roving survey, chinook HPUE for complete and incomplete trip interviews averaged 0.0155 and 0.0108, respectively.

Release: RPUE was estimated from the roving survey at 0.0058 for chinook adults; chinook were not released at any other site. Maximum daily RPUE for chinook adults of 0.021 occurred on August 29.

Harvest

Harvest in the nine day Quesnel River chinook sport fishery totalled 14 chinook adults (including 4 with adipose clips), 3 chinook jacks, 25 rainbow trout, 19 Dolly Varden char and 19 whitefish (Table 2). All of the chinook harvest occurred in the final three days of the fishery.

Release

An estimated 3 chinook adults, 17 rainbow trout and 3 whitefish were released during the Quesnel River chinook sport fishery. All chinook release occurred on the last day of the fishery.

Angler Characteristics

Angler Day Length: Anglers fished an average 3.04 hours during 1986 (Table 3). Angler day length was considerably shorter for complete trip relative to incomplete trip interviews, averaging 3.32 and 5.39 hours, respectively (Appendix 8); however, much of the observed difference was due to the short angler day at Quesnel Forks (2.07 hours). A high proportion of the Quesnel Forks anglers camped in the area; therefore, angler attributes were likely atypical. When Quesnel Forks data were deleted, the angler day length from complete trip interviews was estimated at 4.64 hours. Anglers (excluding Quesnel Forks) fished an average 3.65 and 4.58 hours on clear and overcast days, respectively.

Target Species: Anglers were interested in catching chinook (62%), trout (14%) or anything (25%) (Table 3).

Gear Type: Lures were the most commonly used gear (40%), followed by bait/lure combinations (33%), bait (23%) and flies (4%) (Table 3).

SHUSWAP RIVER, EARLY

Effort Distribution

A total of 214 anglers were interviewed during the study, 99 in the lower and 115 in the middle Shuswap rivers (Appendix 11). Instantaneous rod counts were obtained on three of the four fishing days (Appendix 12). Angling occurred near road access points throughout the lower Shuswap River. Approximately 26% of the total effort occurred between Mara Lake and Enderby, with a further 30% between the Ashton Creek Bridge and Cooke Creek. In the Middle Shuswap River, over half the effort occurred above Bessette Creek, with a further 40% occurring between Bigg and Bessette creeks. Very little effort was observed downstream from Bigg Creek.

Angler Effort

Daily Profile: Anglers fished from 0001 h to 2400 h in the lower Shuswap River and from 0500 h to 2200 h in the middle Shuswap River (Appendix 3; Fig. 6). Daily effort was bimodal in both areas, with peaks at 0700 h and 2100 h in the lower Shuswap and at 0800 h and 1800 h in the middle Shuswap River.

Total Angler Effort: Angler effort during the four day early Shuswap River chinook sport fishery totalled 3,808.4 hours (Table 2). Of that total, 2,022.4 and 1,786.0 hours occurred in the lower and middle Shuswap rivers, respectively.

Catch Per Unit Effort

Harvest: HPUE for chinook adults was estimated at 0.019 and 0.030 in the lower and middle Shuswap rivers, respectively (Appendix 13). The maximum daily HPUE of 0.041 was recorded in the lower Shuswap River on August 5.

Release: No chinook were released during the study period. RPUE for other species is reported in Appendix 13.

Harvest

Harvest during the four day Shuswap River chinook sport fishery was estimated at 92 chinook adults, 16 rainbow trout, 7 Dolly Varden char, 7 whitefish and 16 squawfish (Table 2).

An estimated 39 and 53 chinook adults were harvested in the lower and middle Shuswap rivers, respectively.

Release

An estimated 13 whitefish and 7 suckers were released during the four day opening. No chinook were released.

Angler Characteristics

Angler Day Length: Anglers fished an average 3.52 hours during 1986 (Table 3). Angler day length in the lower and middle Shuswap rivers averaged 3.29 and 3.79 hours, respectively. Angler day length was considerably shorter for complete trip relative to incomplete trip interviews, averaging 2.56 and 5.74 hours, respectively.

Target Species: Anglers were interested in catching chinook (87%), trout (1%) or anything (12%)(Table 3). Virtually all middle Shuswap River anglers were fishing for chinook, while 24% of the lower Shuswap anglers were fishing for "anything".

Gear Type: Lures were the most commonly used gear (58%), followed by bait (29%), bait/lure combinations (12%) and flies (1%) (Table 3). Bait preference was similar in the two fishing areas.

SHUSWAP RIVER, LATE

Effort Distribution

A total of 487 anglers were interviewed during the study, 238 at Chuck's Pool, 159 at Log Dump Pool and 90 in the remaining areas (Appendix 14). Instantaneous rod counts were conducted each day (Appendix 12). As noted during the early fishery, angling occurred near road access points throughout the lower Shuswap River; however, almost two-thirds of the total effort occurred between Cooke Creek and Mabel Lake.

Angler Effort

Daily Profile: Anglers fished throughout the twenty-four hour open period (Appendix 3; Fig. 6). Daily effort was bimodal, with peaks at 0700 h and 1900 h.

Total Angler Effort: Angler effort during the five day Shuswap River chinook sport fishery totalled 6,145 hours (Table 2). Of that total, an estimated 1,763 (28.7%) and 1,311 (21.3%) hours occurred at Chuck's and Log Dump pools, respectively.

Catch Per Unit Effort

Harvest: Weighted HPUE was estimated at 0.0386 for chinook adults and 0.0084 for chinook jacks (Appendix 15). HPUE for chinook adults was highest at Chuck's Pool, totalling 0.0405. HPUE for chinook jacks was highest at Log Dump Pool, totalling 0.0166. The maximum daily HPUE of 0.075 for chinook adults and 0.086 for chinook jacks occurred on September 23 at Chuck's and Log Dump pools, respectively.

Release: RPUE totalled 0.0009 for chinook jacks; chinook adults were not released during the study period (Appendix 15).

Harvest

Harvest in the five day Shuswap River chinook sport fishery was estimated at 237 chinook adults, 53 chinook jacks (including 13 with adipose clips), 3 coho adults, 12 rainbow trout and 4 Dolly Varden char (Table 2).

Release

An estimated 4 chinook jacks were released during the Shuswap River chinook sport fishery (Table 2).

Table 4. Summary of 1986 harvest rate, catchability and harvest per unit effort (HPUE) by fishery.

Fishery	Angler effort (hr)	Chinook adult				
		Harvest	Escapement	Catchability coefficient ($\times 10^{-6}$)	Harvest rate %	Mean HPUE
Bowron River	3,179	13	9,465	0.43	0.14	0.0041
Clearwater River	626	3	5,500	0.87	0.05	0.0048
Quesnel River	1,484	14	9,250	1.02	0.15	0.0116
Early Shuswap:						
Lower Shuswap River	2,022	39	N/A[a]	17.70	3.57	0.0190
Middle Shuswap River	1,786	53	1,000	28.20	5.03	0.0300
Total	3,808	92	1,000	22.10	8.42	0.0242
Late Shuswap:						
Lower Shuswap River	6,145	237	12,000	3.15	1.94	0.0386

[a] No early timing chinook spawn in the lower Shuswap River. An estimated 1,053 middle Shuswap River chinook escaped the fishery.

Angler Characteristics

Angler Day Length: Anglers fished an average 4.91 hours during 1986 (Table 3). Anglers fished for slightly longer periods at Chuck's Pool, averaging 6.07 hours compared to 5.24 hours and 5.30 hours at Log Dump Pool and in the remaining areas, respectively (Appendix 14). Angler day length was considerably shorter for complete trip relative to incomplete trip interviews, averaging 4.91 and 6.75 hours, respectively. Anglers fished an average 5.89, 5.71 and 5.26 hours on clear, overcast and rainy days, respectively.

Target Species: Anglers were interested primarily in catching chinook (97%), trout (0.2%) or anything (3%) (Table 3).

Gear Type: Bait (33%), lures (34%) and bait/lure combinations (33%) were used in approximately equal proportions (Table 3). Less than 1% of the anglers used flies.

DISCUSSION

GENERAL

Bowron River

Although angler effort in the Bowron River was among the largest of the four upper Fraser River sport fisheries, the fishery was one of the least effective harvesters of chinook salmon (Table 4). The harvest rate totalled only 0.14%, and an average of 245 angler hours were required to harvest one chinook adult. There were three probable factors associated with the poor fishery performance. First, catch patterns indicate the fishery opened prior to the arrival of significant numbers of chinook. The first chinook adult was not caught until July 29, the fifth day of the fishery. Subsequent angler interest

increased sharply, with over 75% of the effort expended in the final five days. Second, there were few prime fishing locations in the open area, and limited road access tended to concentrate anglers at Beaver Bridge, the best of the accessible sites. Generally poor fishing sites, and crowding at the prime site may have limited angler success. Third, because the sport fishery had been closed for several years, few anglers had the experience or gear appropriate to chinook fishing. Presumably, effectiveness will increase with learning in subsequent years.

Clearwater River

In 1986, Clearwater River anglers targeted on chinook salmon only in the final three days. In the initial seven days, when 86% of the anglers were fishing for rainbow trout, an average 34.1 angler hours per day were expended to harvest 0.383 fish per hour, 71% of which were rainbow trout. Paish (MS 1973) reported similar effort and catch levels of 50 angler hours per day and 0.4 fish per hour in this fishery in 1971. In contrast, 71% of the anglers contacted during the final three days were fishing for chinook salmon. Both angler day length and average daily effort (135.6 hours) increased despite a sharp decrease in harvest to 0.025 fish per hour. These data, supported by empirical information, suggest chinook abundance was insufficient to attract angler effort prior to early August. When chinook salmon did arrive, relatively high angler interest was demonstrated by increased effort (longer hours, more anglers) and by foregoing trout harvest by using heavier gear and fishing areas more suited to chinook salmon.

The impact of opening the Clearwater River to the retention of chinook adults was minor in terms of both angler use and harvest. Angler effort during the three days of directed chinook fishing totalled only 407 hours, with a peak count of 16 anglers. The harvest rate totalled only 0.05%, and 209 angler hours were required to harvest one chinook adult. Low effort levels probably reflected both opening the fishery on weekdays only which, coupled with the remoteness of the area, made access difficult, and the low success rate of the fishery. The low success rate probably reflected the timing of the fishery relative to the entry of chinook into the river. Because significant numbers of chinook did not enter the river until the final week and a half of the fishery, they tended to be vulnerable only in the lower reaches. Harvestability in those areas was low due to fast water and few landing sites; several were hooked during the fishery but could not be landed (F. Voysey, pers. comm.). It is likely that, had the fishery been extended, effort would have concentrated in areas such as the mouth of Mahood River and the Horseshoe where HPUE would have been higher. Paish (MS 1973) reported 1970-71 average HPUE's of 0.085 and 0.412 chinook per hour (assuming a 4.05 hour angler day) in the Horseshoe area in September and October, respectively. This potential for substantially higher HPUE's should be taken into consideration when planning future fisheries.

Quesnel River

Like the Bowron and Clearwater fisheries, the Quesnel River sport fishery was a relatively ineffective harvester of chinook salmon. The harvest rate totalled 0.15%, and an average of 106 angler hours were required to harvest one chinook salmon adult. Unlike the Bowron and Clearwater fisheries, however, there was no clear explanation for poor fishery performance. The 1986 escapement was among the largest on record, chinook were observed in the river throughout the fishery and prime fishing sites were available. Possible causes were fish

avoidance due to clear water and angler inexperience.

The fishery at Quesnel Forks differed from that in other areas, probably reflecting the high proportion of tourists camping in the area. Anglers fished here for shorter periods, harvested few fish of any species, and no chinook salmon. Future surveys should treat this area as a distinct stratum.

Shuswap River

The Shuswap River was the most intensive of the four upper Fraser River chinook sport fisheries, accounting for 65% (9,953 hours) of the overall angler effort (Table 4). Intense angler interest was demonstrated by the proportion targeting specifically on chinook salmon (94%), and by the proportion of anglers (up to 16% of the total hours fished) fishing early in the morning (before 5:00 AM) and late at night (after 10:00 PM). Angler success was also the highest observed in 1986; an average of only 30 hours was required to harvest one chinook adult. Harvest rate in the early fishery totalled 8.4%, with the fishery in the middle Shuswap River much more effective relative to the lower Shuswap River (Table 4). Because the early fishery was much more effective than anticipated, it was closed after only four of the scheduled seven days. Despite the early closure, total harvest was almost double the fishery catch ceiling of 50 chinook adults. The late fishery, which targeted on the much larger lower Shuswap River stock, attracted almost double the angler effort of the early fishery but harvested at a rate of only 1.9%. Although harvest rate in the late fishery was lower, only 26 hours were required to harvest one chinook adult; however, total catch was below the fishery ceiling.

SURVEY METHODOLOGY

Roving Surveys

Roving surveys were used to assess upper Fraser River sport fisheries when angler distributions could not be predicted, as occurred on the Shuswap River, or when angler effort was extensive but of low intensity, as on the Clearwater and Quesnel rivers. Both factors precluded the use of access point surveys. Although roving surveys were generally less costly, they were avoided if possible because of three potential biases.

Angler Contact Bias: Due to the systematic (rather than random or complete) nature of roving surveys, some anglers have a higher probability of contact than others. Two such biases have been identified in the literature: length of stay bias (Lucas 1963), where the probability of angler contact on any day is proportional to the individual's trip length, and frequency of use bias (Sinclair and Morley 1975), where the probability of contact during the study period is proportional to the individual's trip frequency. The latter bias was considered minimal in the upper Fraser River fisheries because regulations such as opening for only two weekdays per week and fixed fishery catch ceilings promoted relatively intensive, stable angler populations. Length of stay, however, could have significantly biased estimates of angler attributes such as trip length; therefore, corrected trip length estimates were reported by this study. Length of stay bias could also have influenced estimated catch rate if angler catch was related to fishing time. For example, if successful anglers fished for shorter periods than unsuccessful anglers, then length of stay bias would result in an underestimate of catch rate. Although no difference was noted in the trip length of anglers who had caught a chinook adult relative to all anglers, sample sizes

Table 5. Summary of 1986 angler day length (hours) and harvest per unit effort (HPUE) from roving surveys in the upper Fraser Fraser River system.[a]

Area	All anglers: Number of interviews	All anglers: Angler day length [b]	Anglers with chinook harvest: Number of interviews	Anglers with chinook harvest: Angler day length	Harvest per unit effort
Bowron River					
Complete trip interviews	39	3.54 -	2	2.00	0.0145
Incomplete trip interviews	79	4.03 (3.10)	0	-	0.0000
Clearwater River					
Complete trip interviews	22	2.50 -	1	-	0.0182
Incomplete trip interviews	62	5.54 (4.61)	0	-	0.0000
Quesnel River					
Complete trip interviews	26	2.48 -	1	3.00	0.0155
Incomplete trip interviews	146	4.38 (2.70)	3	10.66	0.0108
Lower Shuswap River, Early					
Complete trip interviews	26	2.42 -	2	1.75	0.0317
Incomplete trip interviews	73	4.55 (3.60)	3	4.66	0.0154
Middle Shuswap River, Early					
Complete trip interviews	19	2.74 -	6	2.83	0.1111
Incomplete trip interviews	96	6.65 (4.00)	2	12.75	0.0093
Lower Shuswap River, Late					
Complete trip interviews	20	4.98 -	6	5.17	0.0686
Incomplete trip interviews	70	5.39 (3.89)	3	6.00	0.0121

[a] All data are unweighted, unless otherwise noted.
[b] Bracketed figure corrected for length of stay bias.

were too small for conclusive results (Table 5). When incomplete trip interviews were examined separately (discussed below), chinook adult catch appeared unrelated to angler trip length. This may reflect a general inexperience of anglers due to the extended closures, continued catch-and-release angling after the limit was reached, or a differential probability of contacting short duration successful anglers. Because no relationship was noted, catch rate data from incomplete trips were not treated for length of stay bias.

Incomplete Trip Interview Bias: Sport fishery assessment studies contact anglers either during or at the end of their fishing trip. Because the process of contacting an angler at trip completion is presumably random, data from complete trip interviews is distribution free and will provide an

unbiased estimate of catch rate. In contrast, interviews from fishermen contacted part way through their fishing trip can produce unbiased data only if catch rate at time of interview is an unbiased estimator of catch rate for the angler's complete trip. This assumption is critical in roving surveys because most anglers are contacted prior to trip completion. Although the assumption has proven valid in a number of studies (Carlander **et al.** 1958; Von Geldern 1972; Malvestuto **et al.** 1978; Lewynsky MS 1986; Van Den Avyle 1986), it is contingent upon fishery regulations and should be evaluated on a fishery-specific basis.

A comparison of complete and incomplete trip interview data from the upper Fraser River sport fisheries shows a significant difference in catch rate (HPUE), especially in the Shuswap River fishery (Table 5). Consistently higher catch rates from complete trips may be attributable to the daily catch quota of one chinook adult if successful anglers left the fishery after reaching their limit and thus were differentially vulnerable to the surveyor. Although catch rates could be estimated for the 1986 roving surveys from complete trip interviews only, this approach was deemed inadequate due to small sample sizes. The magnitude of this potential bias can be evaluated by comparing catch rate estimates from the roving and access point surveys. If the bias was large, one would expect catch rate estimates from roving surveys to be significantly lower than from access point surveys. While this was the case in the late Shuswap River fishery, roving survey catch rates were lower in the Bowron and Quesnel fisheries. This suggests that any negative bias was likely to have been small.

Bias in Effort Profile Estimation: Angler effort was estimated using hourly profiles generated from interview data. This technique was used because, due to limited fishing days, it was impossible to allocate sampling effort sufficient for the hourly stratification necessary to maintain estimation precision. The interview technique will provide an unbiased estimate of the daily effort profile if angler contact is randomized and if an angler can estimate trip length subsequent to contact in an unbiased manner. Although angler contact was systematic rather than random, survey procedures were adequate to address the former concern. With respect to the latter, one would expect that a systematic roving survey would contact an average angler approximately half way through his fishing trip. While study data were equivocal, there was no indication of a systematic bias in 1986; therefore, profile estimation bias was unlikely.

Hybrid Surveys

Hybrid studies utilizing access point surveyors were used to assess upper Fraser River sport fisheries where a majority of anglers were known to aggregate at a few sites. Hybrid surveys have two advantages over roving surveys. First, because access point surveys collect primarily complete trip information, angler contact biases and the requirement that catch rate at time of interview be an unbiased estimator of that angler's catch rate at trip completion are both avoided. Robson (1961) identified access point surveys as one effective method to ensure creel survey data were distribution free and that study estimates were unbiased. In view of the potential bias noted in roving survey catch rates, this will continue to be an extremely important consideration as long as these fisheries are regulated to a daily catch quota of one chinook adult. Second, daily effort profiles are measured directly; therefore, potential bias from angler projections of subsequent fishing time is avoided.

A potential problem with hybrid studies is that information recorded at the access point may not be representative of the study area as a whole. This problem was addressed in the design of the upper Fraser River sport fishery studies in two ways. First, hybrid studies were limited to systems were a significant proportion of the anglers were known to concentrate at a few sites. For example, the access sites on the Bowron and Shuswap rivers accounted for 51% and 50% of the respective angler effort in those fisheries. Deviations from attributes measured at these sites, therefore, would have to be very large to bias the study results. Second, the surveyor responsible for instantaneous rod counts also collected catch rate information. Although these data were subject to roving survey biases, they provided a practical significance test for respective catch rates.

RECOMMENDATIONS

1. Strict regulation of the 1986 upper Fraser River sport fisheries was largely successful in constraining chinook harvest to levels well below the fishery ceilings. The impact on the chinook stock rebuilding program, therefore, was minimal. Contingent upon future stock strength, regulations could be relaxed in the Bowron, Clearwater and Quesnel River sport fisheries without exceeding existing fishery ceilings. Regulations in the Shuswap River sport fishery should remain in place in view of the harvest rate and angler effort levels recorded in 1986.

2. The usefulness of 1986 sport fishery assessment data as an indicator of fishery performance in subsequent years is limited by three factors. First, because the fisheries had been closed for a number of years, few anglers had experience in fishing for chinook salmon. Angler effectiveness, therefore, is expected to increase in subsequent years. Second, fishing areas and periods, open days, daily catch quotas and fishery ceilings are likely to change in response to annual fishery assessments. Third, the 1986 fisheries were not advertised outside the local area; therefore, effort levels can be expected to increase as the fisheries become better known. In view of the evolving nature of these fisheries, structured assessment studies should continue until fishery performance stabilizes.

3. Because the daily catch limit of one chinook adult per day could bias roving survey results, future fisheries should be assessed using hybrid study designs when possible.

SUMMARY

1. Sport fisheries for chinook salmon adults were permitted in the Bowron, Clearwater, Quesnel and Shuswap rivers in 1986. Fishery regulations included a fixed fishing period of two weekdays per week, daily and annual chinook catch quotas of one and ten, respectively, and fishery catch ceilings.

2. The fisheries were assessed using either roving or hybrid study designs. The hybrid study design included both access point and roving surveys.

3. Each fishery was assessed by one to three surveyors, depending upon the extent of the open area and the expected effort level. The surveyors, working minimum eight hour shifts on all open days, recorded the following during 1,515 angler interviews:

length of time angling, target species, number and species of fish harvested or released, identifying marks on harvested fish, and gear type.

4. Study period angler effort was estimated at 15,242 hours. Of that total, 3,179, 626, 1,484, 3,808 and 6,145 hours were estimated in the Bowron, Clearwater, Quesnel, early Shuswap and late Shuswap fisheries, respectively. With the exception of the Clearwater River, most anglers were interested primarily in harvesting chinook salmon.

5. Study period harvest totalled 359 chinook adults, 56 chinook jacks, 3 coho adults, 155 rainbow trout, 69 Dolly Varden, 41 whitefish and 16 squawfish. Of the chinook adult harvest, 13, 3, 14, 92 and 237 occurred in the Bowron, Clearwater, Quesnel, early Shuswap and late Shuswap river fisheries, respectively. Four chinook adults (Quesnel River) and 13 chinook jacks (Shuswap River) were marked with adipose fin clips.

6. Study period release totalled 10 chinook adults, 4 chinook jacks, 243 rainbow trout, 1 steelhead trout, 16 Dolly Varden char, 28 whitefish and 7 suckers. Chinook adults were released in the Bowron (7) and Quesnel (3) rivers.

7. Harvest rates ranged from 0.05% to 8.42%. The highest harvest rates were recorded in the Shuswap River fisheries.

8. Roving survey data were examined for potential bias related to angler contact procedures. The daily limit of one chinook adult may have introduced a negative bias if it made incorrect the assumption that catch rate observed at the time of interview is an unbiased estimator of that angler's catch rate at trip completion. No satisfactory alternative was available to generate an unbiased estimate of CPUE.

9. Hybrid surveys were the preferred study technique for three reasons: (1) length of stay and frequency of use biases were eliminated; (2) because information from complete trips was maximized, catch rate could be estimated without bias; and (3) the daily angler effort profile was measured directly.

10. The 1986 fishery regulations were successful in constraining fishery performance and stock impacts within preseason goals. Contingent upon future stock strength, it was recommended that regulations be relaxed in the Bowron, Clearwater and Quesnel fisheries. Current regulations should be maintained in the Shuswap River.

11. Projection of future fishery performance from 1986 data is made difficult by factors such as probable angler learning and inappropriate fishery opening dates. Structured fishery studies were recommended until fishery regulation and performance stabilizes.

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APPENDICES

APPENDIX 1a. SUMMARY OF INTERVIEW RESPONSES BY DAY AT BEAVER ROAD BRIDGE IN THE BOWRON RIVER SPORT FISHERY, JULY 15 TO AUGUST 15, 1986.

	JUL 15	JUL 18	JUL 22	JUL 25	JUL 29	AUG 1	AUG 5	AUG 8	AUG 12	AUG 15	TOTAL
NUMBER OF INTERVIEWS	0	11	21	38	26	32	52	47	47	19	293
WEATHER	0	C	0	0	R	C	0	C	0	C	-
MEAN ANGLER DAY LENGTH (HRS)											
- ALL ANGLERS	-	3.14	3.10	3.22	6.98	6.72	4.54	7.38	6.65	5.18	5.50
- COMPLETE TRIP INTERVIEWS											
NUMBER	0	10	16	28	23	20	37	23	24	16	197
HOURS	-	2.95	3.13	2.95	7.15	5.75	4.35	6.65	4.90	4.84	4.82
- INCOMPLETE TRIP INTERVIEWS											
NUMBER	0	1	5	10	3	12	15	24	23	3	96
HOURS	-	5.00	3.00	4.00	5.67	8.33	5.00	8.08	8.48	7.00	6.90
TARGET SPECIES											
- CHINOOK	-	8	5	25	21	21	44	36	29	9	198
- RAINBOW	-	0	1	1	0	0	3	0	0	0	5
- DOLLY VARDEN	-	0	1	1	0	0	0	0	0	0	2
- ANYTHING	-	3	14	11	5	11	5	11	18	10	88
HARVESTED CATCH											
- CHINOOK	-	0	0	0	0	2	4	0	0	0	6
- RAINBOW	-	0	9	1	2	0	1	0	1	0	14
- DOLLY VARDEN	-	0	4	0	2	1	0	0	3	1	11
RELEASED CATCH											
- CHINOOK	-	0	0	0	1	0	0	2	0	0	3
- RAINBOW	-	0	9	0	4	2	1	1	2	0	19
- DOLLY VARDEN	-	0	5	0	0	0	0	0	2	2	9
- WHITEFISH	-	0	0	0	0	0	0	2	0	0	2
- STEELHEAD	-	0	0	0	0	0	0	1	0	0	1
INSPECTION OF CATCH											
- NUMBER	0	0	4	1	0	3	2	0	0	1	11
- NUMBER CORRECT	-	-	4	1	-	3	2	-	-	1	11
GEAR											
- BAIT	-	2	8	5	2	0	2	0	0	1	20
- LURE	-	5	6	17	17	17	33	22	18	6	141
- BAIT/LURE	-	4	7	16	7	15	17	25	29	11	131
- FLY	-	0	0	0	0	0	0	0	0	1	1
IN B.C. FOR EXPO86											
- YES	0	3	0	0	0	0	0	0	0	0	3
- NO	0	8	21	38	26	32	52	47	47	19	290

APPENDIX 1b. SUMMARY OF INTERVIEW RESPONSES BY DAY FROM THE ROVING SURVEY OF THE BOWRON RIVER SPORT FISHERY JULY 15 TO AUGUST 15, 1986.

	JUL 15	JUL 18	JUL 22	JUL 25	JUL 29	AUG 1	AUG 5	AUG 8	AUG 12	AUG 15	TOTAL
NUMBER OF INTERVIEWS	1	11	12	8	9	22	17	9	17	12	118
WEATHER	O	C	O	O	R	C	O	C	O	C	-
MEAN ANGLER DAY LENGTH (HRS)											
- ALL ANGLERS	0.50	1.86	2.17	2.38	5.39	2.80	5.76	6.78	4.00	4.46	3.87
- COMPLETE TRIP INTERVIEWS											
NUMBER	1	3	1	3	3	9	6	4	6	3	39
HOURS	0.50	0.50	3.00	0.83	3.00	1.50	9.67	5.00	2.75	4.50	3.54
- INCOMPLETE TRIP INTERVIEWS											
NUMBER	0	8	11	5	6	13	11	5	11	9	79
HOURS	-	2.38	2.09	3.10	6.58	3.77	3.64	8.20	4.68	4.44	4.03
TARGET SPECIES											
- CHINOOK	1	5	9	2	7	16	15	7	5	12	79
- DOLLY VARDEN	0	0	0	0	2	0	1	0	0	0	3
- DOLLY VARDEN OR RAINBOW	0	4	0	4	0	2	1	1	2	0	14
- ANYTHING	0	2	3	2	0	4	0	1	10	0	22
HARVESTED CATCH											
- CHINOOK	0	0	0	0	0	2	0	0	0	0	2
- RAINBOW	0	0	1	0	0	0	2	1	0	0	4
- DOLLY VARDEN	0	0	0	0	0	2	0	0	0	0	2
- WHITEFISH	0	1	0	0	0	0	0	0	0	0	1
RELEASED CATCH											
- RAINBOW	0	1	1	0	0	3	0	0	0	0	5
- WHITEFISH	0	1	0	0	0	0	0	0	0	0	1
INSPECTION OF CATCH											
- NUMBER	0	0	1	0	0	3	1	1	0	0	6
- NUMBER CORRECT	-	-	1	-	-	3	1	1	-	-	6
GEAR											
- BAIT	0	4	1	4	2	5	2	1	1	0	20
- LURE	1	6	11	3	4	14	14	5	14	12	84
- BAIT/LURE	0	1	0	1	3	3	1	3	0	0	12
- LURE OR FLY	0	0	0	0	0	0	0	0	2	0	2
IN B.C. FOR EXPO86											
- YES	0	4	0	0	0	0	0	0	0	0	4
- NO	1	7	12	8	9	22	17	9	17	12	114

APPENDIX 2. DAILY ANGLER COUNTS BY REGION IN THE BOWRON RIVER, JULY 15 TO AUGUST 15, 1986.

DATE	TIME	BOWRON FOREST ROAD BRIDGE	HIGHWAY 16 BRIDGE	BEAVER FOREST ROAD BRIDGE	1 KM BELOW BEAVER BRIDGE	TOTAL
JUL 15	1500-1559	0	0	0	0	0
JUL 18	0900-0959	0	1	1	0	2
JUL 22	1600-1659	0	4	4	0	8
JUL 25	1400-1459	3	4	3	0	10
JUL 29	1800-1859	2	0	11	4	17
AUG 1	1000-1059	4	2	14	5	25
AUG 5	1700-1759	0	8	8	10	26
AUG 8	1400-1459	0	6	16	5	27
AUG 12	0700-0759	0	2	14	7	23
AUG 15	1200-1259	0	11	10	0	21

APPENDIX 3. ANGLER EFFORT PROFILES FOR THE BOWRON, CLEARWATER, QUESNEL AND SHUSWAP RIVER SPORT FISHERIES, 1986.

	PROPORTION OF DAILY ANGLER EFFORT						
HOUR	BOWRON	EARLY CLEARWATER	LATE CLEARWATER	QUESNEL	EARLY MIDDLE SHUSWAP	EARLY LOWER SHUSWAP	LATE LOWER SHUSWAP
2400	0.00	0.000	0.000	0.000	0.000	0.000	0.000
100	0.00	0.000	0.000	0.000	0.000	0.009	0.011
200	0.00	0.000	0.000	0.000	0.000	0.009	0.017
300	0.002	0.000	0.000	0.000	0.000	0.012	0.021
400	0.005	0.000	0.000	0.000	0.000	0.026	0.031
500	0.012	0.000	0.000	0.003	0.027	0.028	0.056
600	0.022	0.000	0.000	0.010	0.067	0.071	0.082
700	0.038	0.000	0.013	0.025	0.086	0.078	0.097
800	0.050	0.007	0.023	0.066	0.088	0.061	0.073
900	0.068	0.022	0.049	0.084	0.086	0.059	0.069
1000	0.080	0.036	0.056	0.082	0.073	0.073	0.054
1100	0.105	0.077	0.073	0.097	0.066	0.064	0.046
1200	0.063	0.104	0.094	0.092	0.064	0.063	0.044
1300	0.063	0.074	0.099	0.093	0.048	0.049	0.040
1400	0.053	0.118	0.109	0.096	0.051	0.044	0.032
1500	0.058	0.110	0.109	0.092	0.045	0.022	0.042
1600	0.052	0.119	0.084	0.067	0.035	0.020	0.046
1700	0.050	0.153	0.067	0.050	0.054	0.020	0.050
1800	0.060	0.070	0.043	0.041	0.055	0.028	0.065
1900	0.067	0.022	0.030	0.036	0.054	0.067	0.072
2000	0.059	0.027	0.043	0.037	0.049	0.072	0.032
2100	0.060	0.021	0.039	0.023	0.042	0.056	0.010
2200	0.024	0.027	0.039	0.007	0.011	0.042	0.004
2300	0.007	0.014	0.032	0.000	0.000	0.023	0.003
2400	0.003	0.000	0.000	0.000	0.000	0.007	0.002

APPENDIX 4. ESTIMATED CATCH PER ANGLER HOUR (RELEASE AND HARVEST) IN THE BOWRON RIVER SPORT FISHERY, JULY 15 TO AUGUST 15, 1986.

	JUL 15	JUL 18	JUL 22	JUL 25	JUL 29	AUG 1	AUG 5	AUG 8	AUG 12	AUG 15	TOTAL
HARVEST PER UNIT EFFORT (HPUE)											
A. ROVING SURVEY a											
- CHINOOK	0.000	0.000	0.000	0.000	0.000	0.059	0.000	0.000	0.000	0.000	0.0064
- RAINBOW	0.000	0.000	0.057	0.000	0.000	0.000	0.024	0.022	0.000	0.000	0.0127
- DOLLY VARDEN	0.000	0.000	0.000	0.000	0.000	0.059	0.000	0.000	0.000	0.000	0.0064
- WHITEFISH	0.000	0.074	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.0032
B. BEAVER BRIDGE a											
- CHINOOK	0.000	0.000	0.000	0.000	0.000	0.017	0.020	0.000	0.000	0.000	0.0044
- RAINBOW	0.000	0.000	0.155	0.009	0.011	0.009	0.005	0.000	0.004	0.000	0.0104
- DOLLY VARDEN	0.000	0.000	0.069	0.000	0.011	0.000	0.000	0.000	0.012	0.011	0.0081
C. WEIGHTED, ALL AREAS											
- CHINOOK	-	-	-	-	-	-	-	-	-	-	0.0041
- RAINBOW	-	-	-	-	-	-	-	-	-	-	0.0093
- DOLLY VARDEN	-	-	-	-	-	-	-	-	-	-	0.0080
- WHITEFISH	-	-	-	-	-	-	-	-	-	-	0.0005
RELEASE PER UNIT EFFORT (RPUE)											
A. ROVING SURVEY a											
- RAINBOW	0.000	0.074	0.057	0.000	0.000	0.088	0.000	0.000	0.000	0.000	0.0159
- WHITEFISH	0.000	0.074	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.0032
B. BEAVER BRIDGE a											
- CHINOOK	0.000	0.000	0.000	0.000	0.006	0.000	0.000	0.007	0.000	0.000	0.0022
- RAINBOW	0.000	0.000	0.155	0.000	0.023	0.017	0.005	0.004	0.008	0.000	0.0141
- DOLLY VARDEN	0.000	0.000	0.086	0.000	0.000	0.000	0.000	0.000	0.008	0.021	0.0067
- WHITEFISH	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.007	0.000	0.000	0.0015
- STEELHEAD	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.004	0.000	0.000	0.0007
C. WEIGHTED, ALL AREAS											
- CHINOOK	-	-	-	-	-	-	-	-	-	-	0.0022
- RAINBOW	-	-	-	-	-	-	-	-	-	-	0.0131
- DOLLY VARDEN	-	-	-	-	-	-	-	-	-	-	0.0052
- WHITEFISH	-	-	-	-	-	-	-	-	-	-	0.0013
- STEELHEAD	-	-	-	-	-	-	-	-	-	-	0.0004

a Unweighted

APPENDIX 5. SUMMARY OF INTERVIEW RESPONSES BY DAY IN THE CLEARWATER RIVER SPORT FISHERY, JULY 15 TO AUGUST 15, 1986.

	JUL 15	JUL 18	JUL 22	JUL 25	JUL 29	AUG 1	AUG 5	SUB-TOTAL	AUG 8	AUG 12	AUG 15	SUB-TOTAL	TOTAL
NUMBER OF INTERVIEWS	5	3	6	10	3	3	5	35	20	11	18	49	84
WEATHER	R	O	R	R	R	C	O	-	C	C	C	-	-
MEAN ANGLER DAY LENGTH (HRS)													
- ALL ANGLERS	4.60	4.00	3.67	3.45	5.50	1.67	3.70	3.76	4.60	6.91	5.44	5.43	4.73
- COMPLETE TRIP INTERVIEWS													
NUMBER	5	2	1	6	0	3	1	18	1	1	2	4	22
HOURS	4.60	3.00	4.00	1.25	-	1.67	2.00	2.79	2.00	1.50	0.75	1.25	2.50
- INCOMPLETE TRIP INTERVIEWS													
NUMBER	0	1	5	4	3	0	4	17	19	10	16	45	62
HOURS	-	6.00	3.60	6.75	5.50	-	4.13	4.77	4.74	7.45	6.03	5.77	5.54
TARGET SPECIES													
- CHINOOK	0	0	0	0	0	1	0	1	13	11	11	35	36
- RAINBOW	3	3	4	4	0	2	2	18	4	0	7	11	29
- RAINBOW OR WHITEFISH	2	0	1	1	0	0	0	4	0	0	0	0	4
- RAINBOW OR DOLLY VARDEN	0	0	1	2	3	0	2	8	2	0	0	2	10
- ANYTHING	0	0	0	3	0	0	1	4	1	0	0	1	5
HARVESTED CATCH													
- CHINOOK	0	0	0	0	0	0	0	0	0	0	1	1	1
- RAINBOW	3	1	7	7	3	2	1	24	0	0	2	2	26
- DOLLY VARDEN	0	0	1	2	1	0	1	5	0	0	0	0	5
- WHITEFISH	2	0	0	3	0	0	0	5	0	0	0	0	5
RELEASED CATCH													
- RAINBOW	24	8	3	7	3	5	3	53	8	0	4	12	65
- WHITEFISH	0	0	0	2	1	0	0	3	0	0	0	0	3
INSPECTION OF CATCH													
- NUMBER	2	0	4	5	3	1	2	17	0	0	3	3	20
- NUMBER CORRECT	2	-	4	5	3	1	2	17	-	-	3	3	20
GEAR													
- BAIT	0	0	0	4	0	1	2	7	8	1	7	16	23
- LURE	2	2	4	2	0	1	1	12	9	5	8	22	34
- BAIT/LURE	2	0	2	4	3	0	0	11	3	5	3	11	22
- FLY	0	0	0	0	0	1	2	3	0	0	0	0	3
- FLY AND LURE	1	1	0	0	0	0	0	2	0	0	0	0	2
IN B.C. FOR EXPO86													
- YES	0	0	0	0	0	0	0	0	4	1	0	5	5
- NO	5	3	6	10	3	3	5	35	15	10	18	43	78

APPENDIX 6. DAILY ANGLER COUNTS BY REGION IN THE CLEARWATER RIVER SPORT FISHERY, JULY 15 TO AUGUST 15, 1986.

DATE	TIME	REGION a							TOTAL
		1	2	3	4	5	6	7	
JUL 15	1600-1659	-	-	1	1	3	-	-	5
JUL 18	0800-0859	-	1	-	-	-	-	-	1
JUL 23	b	-	-	-	-	-	-	-	b
JUL 25	1800-1859	-	-	2	-	-	-	-	2
JUL 29	1400-1459	-	-	-	3	-	-	-	3
AUG 01	1800-1859	-	1	3	-	-	-	-	4
AUG 05	1300-1359	-	3	2	-	-	-	-	5
AUG 08	1100-1159	1	8	3	2	2	-	-	16
AUG 12	1200-1259	1	3	2	2	2	-	-	10
AUG 15	1800-1859	1	6	2	2	-	-	-	11

a. REGIONS WERE: 1 - Mouth to Powerline
2 - Powerline to Spahats Creek
3 - Spahats Creek to Hemp Creek
4 - Hemp Creek to 200 m below Mahood River
5 - 200 m below Mahood River to 300 m above Mahood River
6 - 300 m above Mahood River to 200 m below Horseshoe
7 - 200 m below Horseshoe to 400 m above Horseshoe
8 - 400 m above Horseshoe to outlet of Clearwater Lake

b. No rod count due to mud slide.

APPENDIX 7. ESTIMATED CATCH PER ANGLER HOUR (RELEASE AND HARVEST) IN THE CLEARWATER RIVER SPORT FISHERY, JULY 15 TO AUGUST 15, 1986.

	JUL 15	JUL 18	JUL 22	JUL 25	JUL 29	AUG 1	AUG 5	SUB-TOTAL	AUG 8	AUG 12	AUG 15	SUB-TOTAL	TOTAL
HARVEST PER UNIT EFFORT (HPUE) [a]													
- CHINOOK	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.0000	0.000	0.000	0.016	0.008	0.0048
- RAINBOW	0.130	0.100	0.467	0.264	0.667	0.400	0.222	0.2712	0.000	0.000	0.032	0.017	0.1244
- DOLLY VARDEN	0.000	0.000	0.067	0.075	0.222	0.000	0.222	0.0565	0.000	0.000	0.000	0.000	0.0239
- WHITEFISH	0.087	0.000	0.000	0.113	0.000	0.000	0.000	0.0565	0.000	0.000	0.000	0.000	0.0239
RELEASE PER UNIT EFFORT (RPUE) [a]													
- RAINBOW	1.043	0.800	0.200	0.264	0.667	1.000	0.667	0.5989	0.208	0.000	0.063	0.100	0.3110
- WHITEFISH	0.000	0.000	0.000	0.075	0.222	0.000	0.000	0.0339	0.000	0.000	0.000	0.000	0.0144

a. Unweighted.

APPENDIX 8a. SUMMARY OF INTERVIEW RESPONSES BY DAY AT QUESNEL FORKS AND BULLION POOL IN THE QUESNEL RIVER SPORT FISHERY, AUGUST 1 TO 29, 1986.

	QUESNEL FORKS							BULLION POOL			
	AUG 1	AUG 5	AUG 8	AUG 12	AUG 15	AUG 19	TOTAL	AUG 22	AUG 26	AUG 29	TOTAL
NUMBER OF INTERVIEWS	23	12	13	12	10	19	89	25	20	13	58
WEATHER	0	0	C	0	C	0	-	C	C	0	-
MEAN ANGLER DAY LENGTH (HRS)											
- ALL ANGLERS	1.70	2.04	2.15	1.92	1.85	2.68	2.07	3.88	4.90	5.00	4.48
- COMPLETE TRIP INTERVIEWS											
NUMBER	23	12	13	12	10	19	89	25	20	13	58
HOURS	1.70	2.04	2.15	1.92	1.85	2.68	2.07	3.88	4.90	5.00	4.48
- INCOMPLETE TRIP INTERVIEWS											
NUMBER	0	0	0	0	0	0	0	0	0	0	0
HOURS	-	-	-	-	-	-	-	-	-	-	-
TARGET SPECIES											
- CHINOOK	19	3	5	2	5	15	49	20	17	12	49
- RAINBOW	0	2	0	4	0	3	9	0	0	0	0
- DOLLY VARDEN	0	0	0	0	0	0	0	0	3	0	3
- WHITEFISH	0	2	2	0	0	0	4	0	0	0	0
- ANYTHING	4	5	6	6	5	1	27	5	0	1	6
HARVESTED CATCH											
- CHINOOK, UNCLIPPED	0	0	0	0	0	0	0	1	0	0	1
- CHINOOK, CLIPPED	0	0	0	0	0	0	0	1	0	0	1
- RAINBOW	0	0	0	1	0	2	3	2	1	1	4
- DOLLY VARDEN	0	4	9	0	0	0	13	0	0	0	0
- WHITEFISH	2	0	0	0	0	0	2	1	3	4	8
RELEASED CATCH											
- RAINBOW	0	0	0	0	1	0	1	0	0	1	1
INSPECTION OF CATCH											
- NUMBER	2	0	1	1	0	0	4	2	0	2	4
- NUMBER CORRECT	2	-	1	1	-	-	4	2	-	2	4
GEAR											
- BAIT	4	3	3	1	6	4	21	11	3	6	20
- LURE	12	7	10	11	3	9	52	5	3	7	15
- BAIT/LURE	7	0	0	0	0	6	13	9	12	0	21
- FLY	0	2	0	0	1	0	3	0	2	0	2
IN B.C. FOR EXPO86											
- YES	0	0	0	0	0	0	0	0	0	0	0
- NO	23	12	13	12	10	19	89	25	20	13	58

APPENDIX 8b. SUMMARY OF INTERVIEW RESPONSES BY DAY FROM THE ROVING SURVEY IN THE QUESNEL RIVER SPORT FISHERY, AUGUST 1 TO 29, 1986.

	AUG 1	AUG 5	AUG 8	AUG 12	AUG 15	AUG 19	AUG 22	AUG 26	AUG 29	TOTAL
NUMBER OF INTERVIEWS	12	15	19	28	38	17	15	9	19	172
WEATHER	0	0	C	0	C	0	C	C	0	-
MEAN ANGLER DAY LENGTH (HRS)										
- ALL ANGLERS	3.04	5.03	2.19	4.70	2.01	5.24	4.50	8.78	4.16	4.09
- COMPLETE TRIP INTERVIEWS										
NUMBER	0	2	0	7	3	7	1	2	4	26
HOURS	-	1.50	-	3.29	1.83	2.21	0.50	4.00	2.25	2.48
- INCOMPLETE TRIP INTERVIEWS										
NUMBER	12	13	19	21	35	10	14	7	15	146
HOURS	3.04	5.58	2.19	5.17	2.03	7.35	4.79	10.14	6.53	4.38
TARGET SPECIES										
- CHINOOK	7	6	5	18	19	15	14	6	9	99
- RAINBOW	1	6	2	0	6	0	1	0	6	22
- DOLLY VARDEN	0	0	0	2	0	0	0	0	0	2
- RAINBOW/WHITEFISH	0	0	0	0	0	0	0	0	3	3
- ANYTHING	4	3	12	8	13	2	0	3	1	46
HARVESTED CATCH										
- CHINOOK, UNCLIPPED	0	0	0	0	0	0	0	1	2	3
- CHINOOK, CLIPPED	0	0	0	0	0	0	0	1	0	1
- CHINOOK JACK	0	0	0	0	0	1	0	0	0	1
- RAINBOW	0	1	0	0	0	1	0	2	2	6
- DOLLY VARDEN	0	0	0	2	0	0	0	0	0	2
- WHITEFISH	0	0	0	0	0	0	0	0	3	3
RELEASED CATCH										
- CHINOOK	0	0	0	0	0	0	0	0	1	1
- RAINBOW	0	0	0	0	0	0	3	0	1	4
- WHITEFISH	0	0	0	0	0	0	0	0	1	1
INSPECTION OF CATCH										
- NUMBER	0	1	0	1	0	1	0	2	0	5
- NUMBER CORRECT	-	1	-	1	-	1	-	2	-	5
GEAR										
- BAIT	5	2	1	7	13	0	1	3	0	32
- LURE	0	2	14	13	8	11	5	0	7	60
- BAIT/LURE	6	7	4	8	15	5	8	6	12	71
- FLY	0	4	0	0	0	1	1	0	0	6
- LURE OR FLY	1	0	0	0	2	0	0	0	0	3
IN B.C. FOR EXPO86										
- YES	0	0	2	1	0	1	0	0	0	4
- NO	11	15	17	27	38	16	15	9	19	167

APPENDIX 9. DAILY ANGLER COUNTS IN THE QUESNEL RIVER SPORT FISHERY, AUGUST 1 TO 29, 1986.

DATE	TIME	REGION a							TOTAL
		1	2	3	4	5	6	7	
AUG 1	1800-1859	0	0	0	0	0	4	1 b	4
	1900-1959	0	0	0	0	0	4	0 b	4
AUG 5	0800-0859	0	0	0	0	0	8	4 b	8
	1500-1559	0	0	2	0	0	0	3 b	2
AUG 8	1300-1359	2	0	0	1	0	c	3 b	3
	1400-1459	0	0	0	2	4	c	3 b	6
	1600-1659	0	0	0	1	0	0	0 b	1
	1700-1759	0	0	0	0	3	0	1 b	3
AUG 12	1000-1059	0	0	0	6	0	0	2 b	6
	1200-1259	4	0	0	5	0	8	1 b	17
AUG 15	0800-0859	4	0	0	5	0	9	1 b	18
	1100-1159	5	0	0	8	0	13	2 b	26
AUG 19	1200-1259	4	0	0	8	1	5	2 b	18
	1800-1859	0	0	0	6	0	0	5 b	6
AUG 22	0900-0959	3	0	0	5	0	7 b	0	8
	1300-1359	0	0	0	5	1	7 b	2	8
AUG 26	1400-1459	2	0	0	0	0	4 b	0	2
	2000-2059	0	0	0	0	0	1 b	1	1
AUG 29	1400-1459	3	0	0	2	4	0 b	0	9
	1500-1559	9	0	0	3	2	1 b	0	14

a. Regions were: 1 - Quesnel Lake outlet to end of south side access road.
2 - End of road to Likely Bridge, North side.
3 - End of road to Likely Bridge, south side.
4 - Likely Bridge to Drop Creek, North side.
5 - Likely Bridge to Drop Creek, south side.
6 - Drop Creek to 500 m above Cariboo River confluence.
7 - Quesnel Forks area.

b. Access point counts; not included in total.

c. No access.

APPENDIX 10. ESTIMATED CATCH PER ANGLER HOUR (RELEASE AND HARVEST) IN THE QUESNEL RIVER SPORT FISHERY, AUGUST 1 TO 29, 1986.

	AUG 1	AUG 5	AUG 8	AUG 12	AUG 15	AUG 19	AUG 22	AUG 26	AUG 29	TOTAL
HARVEST PER UNIT EFFORT (HPUE)										
A. ROVING SURVEY a										
- CHINOOK, UNMARKED	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.043	0.0087
- CHINOOK, MARKED	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.042	0.000	0.0029
- CHINOOK JACK	0.000	0.000	0.000	0.000	0.000	0.015	0.000	0.000	0.000	0.0029
- RAINBOW	0.000	0.043	0.000	0.000	0.000	0.015	0.000	0.042	0.043	0.0175
- WHITEFISH	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.064	0.0087
- DOLLY VARDEN	0.000	0.000	0.000	0.027	0.000	0.000	0.000	0.000	0.000	0.0058
B. QUESNEL FORKS										
- RAINBOW	0.000	0.000	0.000	0.044	0.000	0.039	-	-	-	0.0163
- DOLLY VARDEN	0.051	0.000	0.000	0.000	0.000	0.000	-	-	-	0.0109
- WHITEFISH	0.000	0.163	0.321	0.000	0.000	0.000	-	-	-	0.0707
C. BULLION POOL										
- CHINOOK, UNMARKED	-	-	-	-	-	-	0.010	0.000	0.000	0.0038
- CHINOOK, MARKED	-	-	-	-	-	-	0.010	0.000	0.000	0.0038
- RAINBOW	-	-	-	-	-	-	0.021	0.010	0.015	0.0154
- DOLLY VARDEN	-	-	-	-	-	-	0.010	0.031	0.062	0.0308
RELEASE PER UNIT EFFORT (RPUE)										
A. ROVING SURVEY a										
- CHINOOK, UNMARKED	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.021	0.0058
- RAINBOW	0.105	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.021	0.0029
- WHITEFISH	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.021	0.0029
B. QUESNEL FORKS										
- RAINBOW	0.000	0.000	0.000	0.000	0.054	0.000	-	-	-	0.0054
C. BULLION POOL										
- RAINBOW	-	-	-	-	-	-	0.000	0.000	0.015	0.0038

a Unweighted

APPENDIX 11. SUMMARY OF INTERVIEW RESPONSES BY DAY IN THE LOWER AND MIDDLE SHUSWAP RIVER SPORT FISHERIES, JULY 29 TO AUGUST 8, 1986.

	LOWER SHUSWAP RIVER					MIDDLE SHUSWAP RIVER				
	JUL 29	AUG 1	AUG 5	AUG 8	TOTAL	JUL 29	AUG 1	AUG 5	AUG 8	TOTAL
NUMBER OF INTERVIEWS	25	31	24	19	99	6	10	40	59	115
MEAN ANGLER DAY LENGTH (HRS)										
- ALL ANGLERS	4.34	4.34	3.69	3.34	3.99	2.08	4.80	3.59	8.24	6.00
- COMPLETE TRIP INTERVIEWS										
NUMBER	11	7	4	4	26	2	2	7	8	19
HOURS	2.64	3.07	1.25	1.88	2.42	2.25	4.50	2.43	2.69	2.74
- INCOMPLETE TRIP INTERVIEWS										
NUMBER	14	24	20	15	73	4	8	33	51	96
HOURS	5.68	4.71	4.18	3.73	4.55	2.00	4.88	3.83	9.11	6.65
TARGET SPECIES										
- CHINOOK	11	26	16	13	66	6	9	40	59	114
- CHINOOK JACK	5	2	0	0	7	0	0	0	0	0
- WHITEFISH	0	2	0	0	2	0	0	0	0	0
- ANYTHING	9	1	8	6	24	0	1	0	0	1
HARVESTED CATCH										
- CHINOOK	0	2	2	1	5	0	1	2	5	8
- CHINOOK JACK	0	0	0	0	0	0	0	0	0	0
- RAINBOW	0	0	0	2	2	0	0	0	0	0
- WHITEFISH	0	2	0	0	2	0	0	0	0	0
- DOLLY VARDEN	0	0	0	0	0	0	0	1	0	1
- SQUAWFISH	0	0	0	20	20	0	0	0	0	0
RELEASED CATCH										
- WHITEFISH	0	0	0	0	0	0	1	0	1	2
- SUCKER	0	0	0	0	0	0	0	0	1	1
INSPECTION OF CATCH										
- NUMBER	0	1	0	3	4	0	1	1	2	4
- NUMBER CORRECT	-	1	-	3	4	-	1	1	2	4
GEAR										
- BAIT	11	4	11	7	33	1	2	7	19	29
- LURE	11	27	13	10	61	2	4	30	27	63
- BAIT/LURE	2	0	0	2	4	3	4	3	12	22
- FLY	1	0	0	0	1	0	0	0	1	1
IN B.C. FOR EXPO86										
- YES	0	0	0	0	0	0	0	0	0	0
- NO	24	26	22	19	91	1	9	40	55	105

APPENDIX 12a. DAILY ANGLER COUNTS BY SUBAREA IN THE SHUSWAP RIVER SPORT FISHERY, MARA LAKE TO ASHTON CREEK BRIDGE, JULY 29 TO SEPTEMBER 23, 1986.

		MARA LAKE TO ASHTON CREEK BRIDGE a				
DATE	TIME	1	2	3	4	TOTAL
JUL 29	1500-1559	3	2	2	3	10
AUG 1	1200-1259	0	0	0	0	0
AUG 5	1700-1759	1	1	3	1	6
	1900-1959	0	9	10	1	20
AUG 8	0800-0859	5	2	0	0	7
SEP 9	0600-0659	1	4	1	0	6
SEP 12	1800-1859	12	9	6	0	27
SEP 16	0600-0659	0	0	15	3	18
SEP 19	1900-1959	9	10	17	4	40
SEP 23	0600-0659	2	3	1	0	6

a. SUBAREAS WERE: 1 - Mara Lake to Mara Bridge
2 - Mara Bridge to Grinrod
3 - Grinrod Bridge to Enderby Bridge
4 - Enderby Bridge to Ashton Cr. Bridge

APPENDIX 12b. DAILY ANGLER COUNTS BY SUBAREA IN THE SHUSWAP RIVER SPORT FISHERY, ASHTON CREEK BRIDGE TO MABEL LAKE, JULY 29 TO SEPTEMBER 23, 1986.

		ASHTON CREEK BRIDGE TO MABEL LAKE a					
DATE	TIME	1	2	3 b	4	5 c	TOTAL
JUL 29	-	-	-	-	-	-	-
AUG 1	1100-1159	4	4	0	2	2	12
AUG 5	1500-1559	3	0	0	2	0	5
AUG 8	0800-0859	0	9	2	0	13	24
SEP 9	0600-0659	0	2	20	6	26	54
SEP 12	1900-1959	6	15	15	4	20	60
SEP 16	0700-0759	5	11	42	0	51	109
SEP 19	1800-1859	5	10	14	2	35	66
SEP 23	0700-0759	5	5	7	1	50	68

a. SUBAREAS WERE: 1 - Ashton Cr. Bridge to Fall Cr.
2 - Fall Cr. to Cook Cr.
3 - Cook Cr. to Delorne Cr.
4 - Delorne Cr. to Skookumchuck
5 - Skookumchuck to Mabel Lake

b. INCLUDES LOG DUMP POOL.

c. INCLUDES CHUCK'S POOL.

APPENDIX 12c. DAILY ANGLER COUNTS BY SUBAREA IN THE SHUSWAP RIVER SPORT FISHERY, MABEL LAKE TO SHUSWAP FALLS, JULY 29 TO AUGUST 8, 1986.

		MABEL LAKE TO SHUSWAP FALLS a				
DATE	TIME	1	2	3	4	TOTAL
JUL 29	-	-	-	-	-	-
AUG 1	0800-0859	0	2	15	15	32
AUG 5	1500-1559	0	0	10	10	20
AUG 8	1200-1259	0	0	3	16	19

a. SUBAREAS WERE: 1 - Mabel Lake to Ireland Cr.
2 - Ireland Cr. to Bigg Cr.
3 - Bigg Cr. to Bessette Cr.
4 - Bessette Cr. to Shuswap Falls

APPENDIX 13. ESTIMATED CATCH PER ANGLER HOUR (RELEASE AND HARVEST) IN THE LOWER AND MIDDLE SHUSWAP RIVER SPORT FISHERIES, JULY 29 TO AUGUST 8, 1986 a.

	JUL 29	AUG 1	AUG 5	AUG 8	TOTAL
HARVEST PER UNIT EFFORT (HPUE)					
A. MIDDLE SHUSWAP RIVER					
- CHINOOK	0.000	0.029	0.031	0.031	0.030
- DOLLY VARDEN	0.000	0.000	0.015	0.000	0.004
B. LOWER SHUSWAP RIVER					
- CHINOOK	0.000	0.020	0.041	0.025	0.019
- RAINBOW	0.000	0.000	0.000	0.050	0.008
- WHITEFISH	0.000	0.020	0.000	0.000	0.008
- SQUAWFISH	0.000	0.000	0.000	0.500	0.078
RELEASE PER UNIT EFFORT (RPUE)					
A. MIDDLE SHUSWAP RIVER					
- WHITEFISH	0.000	0.029	0.000	0.006	0.007
- SUCKER	0.000	0.000	0.000	0.006	0.004

a Unweighted

APPENDIX 14a. SUMMARY OF INTERVIEW RESPONSES BY DAY IN THE MIDDLE SHUSWAP RIVER SPORT FISHERY, SEPTEMBER 9 TO 23, 1986.

	ROVING SURVEY						LOG DUMP POOL					
	SEP 9	SEP 12	SEP 16	SEP 19	SEP 23	TOTAL	SEP 9	SEP 12	SEP 16	SEP 19	SEP 23	TOTAL
NUMBER OF INTERVIEWS	22	19	20	19	10	90	21	35	53	24	26	159
WEATHER	O	C	O	O	R	-	O	C	O	O	R	-
MEAN ANGLER DAY LENGTH (HRS)												
- ALL ANGLERS	5.00	5.58	4.85	6.47	4.10	5.30	3.00	4.39	6.45	4.63	6.31	5.24
- COMPLETE TRIP INTERVIEWS												
NUMBER	6	4	7	3	0	20	17	35	36	20	10	118
HOURS	4.25	5.75	6.14	2.67	-	4.98	2.79	4.39	5.97	4.85	3.60	4.65
- INCOMPLETE TRIP INTERVIEWS												
NUMBER	16	15	13	16	10	70	4	0	17	4	16	41
HOURS	5.28	5.53	4.15	7.19	4.10	5.39	3.88	-	7.47	3.50	8.00	6.94
TARGET SPECIES												
- CHINOOK	22	19	20	19	10	90	21	34	53	12	25	145
- RAINBOW	0	0	0	0	0	0	0	0	0	0	0	0
- ANYTHING	0	0	0	0	0	0	0	1	0	12	1	14
HARVESTED CATCH												
- CHINOOK	3	4	1	1	0	9	3	5	16	1	3	28
- CHINOOK JACK, UNCLIPPED	0	4	0	0	0	4	1	0	2	0	8	11
- CHINOOK JACK, CLIPPED	0	0	0	0	0	0	3	0	0	0	0	3
- COHO	0	0	0	0	0	0	0	0	0	0	0	0
- RAINBOW	0	0	0	0	0	0	0	0	0	0	0	0
- WHITEFISH	0	0	0	0	0	0	0	0	0	2	0	2
- DOLLY VARDEN	0	0	0	0	0	0	0	1	0	0	0	1
- SQUAWFISH	0	0	0	0	0	0	0	0	0	0	0	0
RELEASED CATCH												
- CHINOOK JACK, UNCLIPPED	0	0	0	0	0	0	0	0	0	0	0	0
- WHITEFISH	0	0	0	0	0	0	0	0	0	0	0	0
- SQUAWFISH	0	0	0	0	0	0	1	0	0	0	0	1
INSPECTION OF CATCH												
- NUMBER	3	4	0	1	0	8	3	6	13	2	6	30
- NUMBER CORRECT	3	4	-	1	-	8	3	6	13	2	6	30
GEAR												
- BAIT	8	9	10	2	3	32	7	10	18	5	11	51
- LURE	14	10	10	15	5	54	12	12	14	5	5	48
- BAIT/LURE	0	0	0	2	2	4	2	12	21	14	10	59
- FLY	0	0	0	0	0	0	0	1	0	0	0	1
IN B.C. FOR EXPO86												
- YES	0	0	0	0	0	0	0	0	0	0	0	0
- NO	22	19	20	19	10	90	21	35	53	24	24	157

APPENDIX 14b. SUMMARY OF INTERVIEW RESPONSES BY DAY IN THE MIDDLE SHUSWAP RIVER SPORT FISHERY, SEPTEMBER 9 TO 23, 1986 CONTINUED.

	CHUCK'S POOL					
	SEP 9	SEP 12	SEP 16	SEP 19	SEP 23	TOTAL
NUMBER OF INTERVIEWS	23	46	48	53	68	238
WEATHER	0	C	0	0	R	-
MEAN ANGLER DAY LENGTH (HRS)						
- ALL ANGLERS	6.09	7.17	6.56	5.97	5.04	6.07
- COMPLETE TRIP INTERVIEWS						
NUMBER	15	35	30	34	37	151
HOURS	5.33	6.01	4.83	5.54	3.97	5.11
- INCOMPLETE TRIP INTERVIEWS						
NUMBER	8	11	18	19	31	87
HOURS	7.50	10.86	9.44	6.74	6.32	7.75
TARGET SPECIES						
- CHINOOK	22	46	47	53	68	236
- RAINBOW	0	0	1	0	0	1
- ANYTHING	1	0	0	0	0	1
HARVESTED CATCH						
- CHINOOK	2	9	11	11	19	52
- CHINOOK JACK, UNCLIPPED	1	0	0	1	1	3
- CHINOOK JACK, CLIPPED	0	0	0	1	0	1
- COHO	0	0	0	0	1	1
- RAINBOW	1	1	2	0	0	4
- WHITEFISH	0	0	0	0	0	0
- DOLLY VARDEN	0	0	0	0	0	0
- SQUAWFISH	0	0	0	0	0	0
RELEASED CATCH						
- CHINOOK JACK, UNCLIPPED	0	0	0	1	0	1
- WHITEFISH	0	0	1	0	0	1
- SQUAWFISH	0	2	0	0	0	2
INSPECTION OF CATCH						
- NUMBER	4	9	12	11	19	55
- NUMBER CORRECT	4	9	12	11	19	55
GEAR						
- BAIT	6	8	17	25	20	76
- LURE	3	10	11	9	30	63
- BAIT/LURE	14	28	19	19	18	98
- FLY	0	0	1	0	0	1
IN B.C. FOR EXPO86						
- YES	0	0	0	0	0	0
- NO	23	46	48	53	68	238

APPENDIX 15. ESTIMATED CATCH PER ANGLER HOUR (RELEASE AND HARVEST) IN THE LOWER SHUSWAP RIVER SPORT FISHERY, SPETEMBER 9 TO 23, 1986.

	SEP 9	SEP 12	SEP 16	SEP 19	SEP 23	TOTAL
HARVEST PER UNIT EFFORT (HPUE)						
A. ROVING SURVEY a						
- CHINOOK	0.035	0.053	0.012	0.013	0.000	0.0260
- RAINBOW	0.000	0.053	0.000	0.000	0.000	0.0110
- WHITEFISH	0.000	0.000	0.000	0.000	0.000	0.0000
- SQUAWFISH	0.000	0.000	0.000	0.000	0.000	0.0000
B. LOG DUMP POOL a						
- CHINOOK	0.054	0.033	0.051	0.009	0.032	0.0355
- CHINOOK JACK, UNCLIPPED	0.018	0.000	0.006	0.000	0.086	0.0130
- CHINOOK JACK, CLIPPED	0.054	0.000	0.000	0.000	0.000	0.0036
- WHITEFISH	0.000	0.000	0.000	0.019	0.000	0.0028
- DOLLY VARDEN	0.000	0.007	0.000	0.000	0.000	0.0018
C. CHUCK'S POOL a						
- CHINOOK	0.019	0.031	0.048	0.041	0.075	0.0405
- CHINOOK JACK, UNCLIPPED	0.009	0.000	0.000	0.004	0.004	0.0024
- CHINOOK JACK, CLIPPED	0.000	0.000	0.000	0.004	0.000	0.0011
- COHO	0.000	0.000	0.000	0.000	0.004	0.0007
- RAINBOW	0.009	0.003	0.009	0.000	0.000	0.0031
D. WEIGHTED, ALL AREAS						
- CHINOOK	-	-	-	-	-	0.0386
- CHINOOK JACK, UNCLIPPED	-	-	-	-	-	0.0064
- CHINOOK JACK, CLIPPED	-	-	-	-	-	0.0020
- COHO	-	-	-	-	-	0.0004
- RAINBOW	-	-	-	-	-	0.0020
- WHITEFISH	-	-	-	-	-	0.0009
- DOLLY VARDEN	-	-	-	-	-	0.0007
RELEASE PER UNIT EFFORT (RPUE)						
A. CHUCK'S POOL a						
- CHINOOK JACK, UNCLIPPED	0.000	0.000	0.000	0.004	0.000	0.0009
- WHITEFISH	0.000	0.000	0.004	0.000	0.000	0.0009
- SQUAWFISH	0.000	0.007	0.000	0.000	0.000	0.0017

a. Daily CPUE is unweighted; fishery total is weighted.

Appendix 16. Variance estimation procedure for access point surveys (adapted from DPA Group Inc. (MS 1985a)).

CATCH (C)

$$(1)\ \mathrm{Var}(C) = \bar{c}^2\ E^2 \left[\frac{\mathrm{Var}(E)}{E^2} + \frac{\mathrm{Var}(\bar{c})}{\bar{c}^2} + \frac{\mathrm{Var}(E)\mathrm{Var}(\bar{c})}{\bar{c}^2\ E^2} \right]$$

where: E = estimated study period effort (hours),
$\mathrm{Var}(E)$ = variance of the estimated study period effort (see equation 2),
$\bar{c}$ = estimated study period catch per angler hour,
$\mathrm{Var}(\bar{c})$ = variance of the estimated study period catch per angler hour (see equation 3).

EFFORT (E)

$$(2)\ \mathrm{Var}(E) = N^2 \left[\frac{\bar{y}_j^*}{\bar{p}_j^*} \right]^2 \left[\frac{\mathrm{Var}(\bar{y}_j^*)}{\bar{y}_j^{*2}} + \frac{\mathrm{Var}(\bar{p}_j^*)}{\bar{p}_j^{*2}} - \frac{2\ \mathrm{Cov}(\bar{y}_j^*, \bar{p}_j^*)}{(\bar{y}_j^*)(\bar{p}_j^*)} \right]$$

where: N = total days in study period,
$\bar{y}_j^*$ = mean instantaneous rod count (hour j*),
$\mathrm{Var}\ \bar{y}_j^*$ = variance at the mean rod count at hour j* (see equation 4),
$\bar{p}_j^*$ = proportion of daily angler hours occurring at time of instantaneous rod count,
$\mathrm{Var}\ \bar{p}_j^*$ = variance of the proportion of daily angler hours occurring at time of instantaneous rod count (see equation 5).

CATCH PER UNIT EFFORT ($\bar{c}$)

Because $\bar{c}$ is a ratio of catch to time of interview ($\hat{x}$) and time fished to time of interview ($\hat{t}$), a Taylor series approximation to the variance of the ratio of random variables was used. Because we expected to interview a relatively large proportion of the anglers, especially at the access point sites, the greatest variance was expected to occur at the stint level; consequently, the following estimate embodies only that sampling stage.

$$(3)\ \mathrm{Var}(\bar{c}) = \left[\frac{\hat{x}}{\hat{t}} \right]^2 \left[\frac{\mathrm{Var}(\hat{x})}{\hat{x}^2} + \frac{\mathrm{Var}(\hat{t})}{\hat{t}^2} - \frac{2\ \mathrm{Cov}(\hat{x}, \hat{t})}{(\hat{x})(\hat{t})} \right]$$

where:
$$\mathrm{Cov}(\hat{x}, \hat{t}) = \sum_i \sum_l N^2\ (1/n_{ij} - 1/N) \sum_f \left[\frac{(\hat{x}_{ilf}\hat{t}_{ilf}) - 1/n_{ij} \sum_f \hat{x}_{ilf} \sum_i \hat{t}_{ilf}}{n_{ij} - 1} \right]$$

$$\mathrm{Var}(\hat{x}) = \sum_i \sum_l N^2\ (1/n_{ij} - 1/N) \sum_f \left[\frac{(\hat{x}_{ilf} - (1/n_{ij} \sum_f \hat{x}_{ilf}))^2}{n_{ij} - 1} \right]$$

$\mathrm{Var}(\hat{t})$ is analogous to above.

$\hat{X}_{ilf}$ = estimated total catch for the f^{th} stint of the l^{th} stint type at the i^{th} site,

$\hat{T}_{ilf}$ = estimated total angler hours for the f^{th} stint of the l^{th} stint type at the i^{th} site,

n_{ij} = number of interview sample days at site i on hour j.

MEAN INSTANTANEOUS ROD COUNT ($\bar{y}_j^*$)

$$(4)\ \mathrm{Var}(\bar{y}_j^*) = (1/n_j^* - 1/N) \sum_k \left[\frac{(y_j^*{}_k - \bar{y}_j^*)^2}{n_j^* - 1} \right]$$

where: n_j^* = number of instantaneous rod counts at hour j*,

$y_j^*{}_k$ = instantaneous rod count (all sites) on day k,

$\bar{y}_j^*$ = estimated mean rod count at hour j*.

PROPORTION OF DAILY EFFORT AT TIME OF INSTANTANEOUS ROD COUNT ($\bar{p}_j^*$).

Because $\bar{p}_j^*$ is a ratio of $\hat{R}_j^*$ and $\sum R_j$, the following Taylor Series approximation to the variance of the ratio at random variables was used:

$$(5)\ \mathrm{Var}(\bar{p}_j^*) = \left[\frac{\hat{R}_j^*}{\sum_j \hat{R}_j} \right]^2 \left[\frac{\mathrm{Var}(\hat{R}_j^*)}{\hat{R}_j^{*2}} + \frac{\mathrm{Var} \sum_j \hat{R}_j}{\sum_j \hat{R}_j^2} - \frac{2\ \mathrm{Cov}(\hat{R}_j^*, \sum_j \hat{R}_j)}{(\hat{R}_j^*)\ (\sum_j \hat{R}_j)} \right]$$

where:

$$\mathrm{Cov}(\hat{R}_j^*, \sum_j \hat{R}_j) = \sum_i N^2 (1/n_{ij}^* - 1/N) \sum_k \left[\frac{(r_{ij}^*{}_k \sum_j r_{ijk}) - (1/n_{ij}^* \sum_k r_{ij}^*{}_k \sum_i \sum_j r_{ijk})}{n_{ij}^* - 1} \right]$$

$$\mathrm{Var}(\hat{R}_j^*) = \sum_i N^2 (1/n_{ij}^* - 1/N) \sum_k \left[\frac{(r_{ij}^*{}_k - (1/n_{ij}^* \sum_k r_j^*{}_k))^2}{n_{ij}^* - 1} \right]$$

$\mathrm{Var} \sum_j \hat{R}_j$ is analagous to above.

N = number of days in stratum,

n_{ij}^* = number of interview sample days at site i,

r_{ijk} = rod count at site i at hour j on day k,

$r_{ij}^*{}_k$ = rod count at site i on day k at the hour of the instantaneous effort count,

$\hat{R}_j^*$ = estimated total effort (rod hours) during the instantaneous rod count time block,

$\sum_j \hat{R}_j$ = estimated number of rods hours over all hours and days at the sites surveyed.